THE WEEK'S EVENTS

Low Cost Achieved On Red Hook

Bids indicate construction cost of $850 per room for Red Hook housing project

When bids were opened Sept. 13 on the Red Hook USHA-financed housing project in New York City, it was found that the cost of construction will be about $12,000,000, or $4,600,000 lower than the budget allowed by the U. S. Housing Authority.

Contract for construction of the superstructure has been awarded to the George A. Fuller Construction Co. of New York City on its low bid of $7,243,000.

The low figure at which the superstructure contract was awarded insured that the cost of construction will be only $850 per room, although a cost of $1,250 is permitted under the terms of the Wagner-Steagall housing act.

The construction cost per room of Williamsburg Houses, built by the housing division of PWA, was about $1,500. Moreover, the land cost of the Red Hook project is only $275, as compared with a cost of nearly $700 for Williamsburg.

Chairman Alfred Rheinstein of the New York City Housing Authority expects that similar economies will be achieved on the Queensbridge housing project on which bids are to be opened in October. If this expectation is fulfilled, it will be possible to house 31,000 persons with the money made available by the USHA, whereas originally it had been expected to house only 22,000. These figures are for the combined Red Hook and Queensbridge developments.

Work on the foundations at Red Hook has been under way since July 7. It is expected that seven structures will be completed by June, 1939, and the remaining units of the project will be ready for occupancy in the late summer or early fall of the same year.

The Red Hook project buildings will be six stories high, entirely fireproof, and will be of steel and masonry construction. The buildings will have self-operating elevators, and apartments will be equipped with electrical refrigerators, gas ranges, clothes dryers and kitchen cabinets. Buildings in the development will cover only 23 per cent of the land area.

MAJOR NEWS

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DRILLING BEGINS ON SANTEE-COOPER

FIRST dirt moves on the Santee-Cooper hydro-electric and navigation project as officials of the South Carolina Public Service Authority watch the inauguration of core drilling.

The $37,500,000 Santee-Cooper project involves diversion of water from the Santee River to the Cooper River through an artificial channel. Two reservoirs will have a total capacity of 1,400,000 acre-ft., and an 8-unit power house will generate 200,000 kw.

Small Ohio Dam Carried Out

Heavy rains on Sept. 14 carried out a small dam on Pratt Fork Creek in Athens County, Ohio. Failure of the dam destroyed Rainbow Lake, a 26-acre body of water used as a private fishing spot. A number of nearby farms were flooded, causing heavy damage to crops.

The dam, an earth fill structure, had a concrete spillway.

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Underground Parking Lot Planned in Detroit

The City of Detroit has made application for PWA assistance in the construction of an underground municipal parking lot under Washington Boulevard and Cadillac Square. The proposed lot would be a two level structure mechanically ventilated and lighted and approached by spiral ramps. It would have a capacity of 2,000 cars.

It is planned to relieve downtown street congestion, after the parking lot is built, by stricter parking rules on certain streets.

The city plans to raise its share of the $4,190,000 cost of the project by 30 year bonds to be repaid out of revenues. Charges for parking would be similar to those made by private garages.

New Boston Aqueduct For Quabbin Water

PWA makes seven million dollar grant to complete reservoir and build supply line

Aided by a PWA grant of $6,984,000, the Metropolitan District Water Supply Commission of Boston will complete the Quabbin Reservoir works and provide an additional aqueduct to carry the Quabbin supply into the city. The total cost of the project will be $15,522,000.

New supply line

The new aqueduct will provide a double supply line from the present terminal of the Wachusett Aqueduct above Sudbury Reservoir to distribution reservoirs within the district. Adequate supply for years to come will be supplied by the Ware and Swift rivers in the Quabbin project. The new aqueduct will permit cutting out the less desirable water from Sudbury reservoir and holding it as an emergency supply.

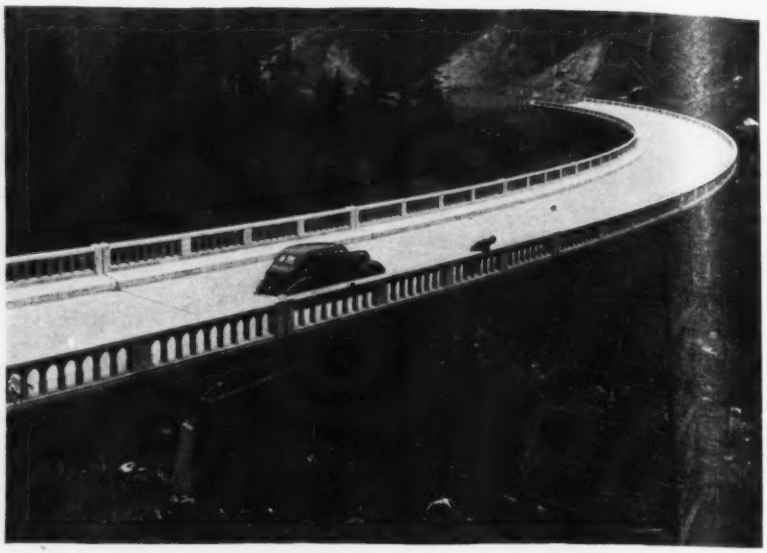
About $11,000,000 will be required for the aqueduct, extending for 18½ miles from the Wachusett Aqueduct terminal to a point near the terminal of the Weston Aqueduct adjacent to the Charles River, with a connection at the upper end of the Weston line. Capacity of the Weston Aqueduct will be enlarged by additional siphons at the Sudbury River and Happy Hollow crossings, now single siphons. Of the 18½ miles of new aqueduct, 3½ miles will be in rock tunnel, the remainder in cut-and-cover pressure conduit of circular concrete section lined with steel. Ultimate plans call for extension of the new aqueduct by conduits to Chestnut Hill Reservoir and the Spot Pond pumping station.

Quabbin Reservoir work

The work to be done at Quabbin Reservoir includes clearing 20,000 acres inside the flowage line; building two low-flow regulating dams on Middle and Eastern branches of the Swift River; and construction of 4 miles of bituminous road connecting Quabbin Dam and Quabbin Dike. Also, service buildings are to be provided at Shafts 1 and 8 of the Quabbin Aqueduct. The clearing will prepare the reservoir for filling, scheduled to start next summer after completion of Quabbin Dam.

Bids have already been received on the service buildings and the regulating dams, and clearing of the reservoir will begin at once. The rock tunnel section will probably be advertised next month, followed shortly by call for bids on the proposed pressure conduit.

The work is in charge of the Metropolitan District Water Supply Commission. Frank E. Winsor is chief engineer, and Karl R. Kennison is assistant chief engineer.



UNUSUAL CURVED BRIDGE IN OREGON

RISING on a 6 per cent grade and swinging around a 10 degree curve, this 602 ft. bridge over Meahkahnie Creek, is part of a new section of the Coast highway in Oregon. The 26-ft. roadway has a superelevation of 2.86 ft.

The 90-ft. high trestle bridge was built at a cost of $83,000.

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Low Bid on Prado Dam Million Below Estimate

When bids for construction of the Prado Dam on the Santa Ana River, second major project in the Army flood protection program in Southern California, were opened, the low bid of $3,641,000 was nearly a million dollars below the engineers' estimate of $4,570,000. This bid was offered jointly by W. E. Callahan Construction Co. of Los Angeles and Guthrie, Marsch, Peterson Co. of Chicago.

The dam, to be finished within 925 days, is an earth fill structure with a crest length of 2,280 ft. and a maximum height of 105 ft. above the valley floor. It is located in a constriction of the Santa Ana channel at the lower end of a wide basin; it will thus have a reservoir capacity of 224,500 acre-ft. at spillway level.

Outlet provisions include two 60-in. open gates and six controlled gates with a total flow of 9,200 sec.-ft. An ogee spillway will be 1,100 ft. long and 1,000 ft. wide.

In addition, one 60-in. pipe will traverse the entire length of the dam base to permit passage of water which would normally go underground through the permeable sand in the stream bed but which will be stopped by the dam cutoff wall. Downstream owners have rights to this water.

A concrete crib will be built at the foot of the ogee to prevent undercutting. This will be composed of 5-ft. walls 90 ft. deep on 50-ft. centers, connected by frequent laterals.

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PWA Application Revised On Battery Tunnel

In order to meet the requirement that projects receiving PWA aid must be completed by June 30, 1940, New York City has submitted a revised application for a PWA grant on the proposed Battery tunnel connecting Manhattan and Brooklyn. Under the new plan, only that part of the work which could be completed before the deadline is set up as a PWA project. The amount of the grant asked from PWA is thus reduced from $31,882,000 to $12,000,000. At the same time, changes in plans for approach structures were made which raise the estimated total cost from $70,850,000 to $77,735,000.

Under present plans, the city hopes to obtain $12,000,000 of the cost as a grant from PWA, $45,852,000 as a loan from the Reconstruction Finance Corp., and $19,882,000 through the sale of municipal bonds.

Pennsylvania School Bids Rejected Second Time

Bids have been rejected for the second time on construction of the industrial school for boys at Whitehill, Pa. The Pennsylvania General State Authority has announced that because it received only one bid on Aug. 23, it will ask for new bids on the project, to be opened Oct. 14.

McCloskey & Co. of Philadelphia were the sole bidders at the August opening, offering to do the general construction for $2,114,000. After conferring with PWA authorities, the authority determined that it could not make the award when there was only one bidder.

The first time that bids were received on this project, they exceeded the funds allocated for the project and all were rejected.

CONTRACTS AND CAPITAL

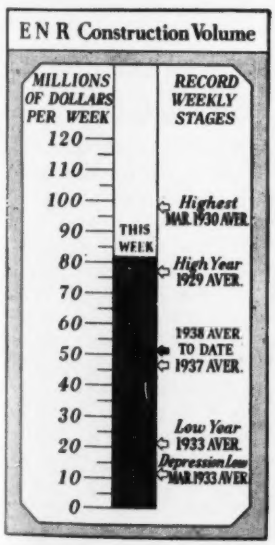
ENGINEERING construction awards for the week, $82,252,000, are the highest since the week of June 24, 1937, and exceed their 1937 values for the tenth consecutive week. Awards are 53 per cent above last week and 95 per cent above the corresponding 1937 week.

Cumulative construction volume for 1938 to date, $1,955,031,000, is 6.0 per cent ahead of the volume for the 38-week period last year.

Public construction, at its highest level since January 9, 1936, is 58 per cent higher than last week, and 177 per cent higher than last year. Private construction is 30 per cent above the preceding week, but 35 per cent below the 1937 week.

Highway lettings, $26,509,000, are the highest recorded in the past five years, due partially to five large programs in four states totaling $12,600,000, and numerous smaller farm-to-market roads throughout the country. Public buildings report the highest week since January 9, 1936. Large USHA slum-clearance low-cost housing awards in New York City, school building programs in various states, and federal building projects in Washington and Kentucky are responsible. The $7,282,000 North Beach, N. Y., airport project helps bring the unclassified total to its highest week since July 8, 1937. In addition to these three classes of construction, waterworks, commercial building and large-scale housing, and earthwork and drainage are higher than their volumes of both last week and last year.

New capital for construction, $68,413,000, is 128 per cent above the 1937 week. Construction financing for 38 weeks of 1938 totals $3,060,480,000, an increase of 54 per cent over the volume for the corresponding 1937 period.



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CONTRACTS

(Thousands of dollars)

	Week Ending Sept. 23 1937	Sept. 15 1938	Sept. 22 1938
Federal	$2,138	$9,304	$7,451
State & Municipal	23,756	36,113	64,237
Total public	$25,894	$45,417	$71,688
Total private	16,283	8,152	10,564
TOTALS	$42,177	$53,569	$82,252
Cumulative 1938 (38 weeks)			$1,955,031
Cumulative 1937 (38 weeks)			$1,843,514

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 38 Wk.	1938 38 Wk.
NON-FEDERAL	$1,244,260	$1,915,782
Corporate securities	440,597	332,077
State & Mun. bonds	396,178	433,831
PWA loans, grants	177,546	628,770
RFC loans	29,939	97,391
U.S.H.A. loans	.....	202,807
R.E.A. loans	.....	19,406
Federal Aid-highways	200,000	201,500
FEDERAL	$746,223	$1,144,698
TOTAL CAPITAL	$1,990,483	$3,060,480

FHA MORTGAGES

	Cumulative 1937 37 Wk.	1938 37 Wk.
Mortg. selected for appraisal	$463,631	$718,173

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Sept.	232.70	111.86
Building Cost	Sept.	194.80	105.30
Volume	Aug.	218	96

Florida Materials Dealers Told to End Monopoly

Dealers in building materials and supplies controlling about 70 per cent of the purchasing power of lumber and other building materials in Florida and their association, Florida Building Materials Institute, Orlando, have been ordered by the Federal Trade Commission to cease and desist from practices tending to create a monopoly, it was announced Sept. 16.

The institute, according to the commission, is composed of about 280 active dealer members, all located in Florida, and 47 manufacturers and wholesalers designated as associate members. About 288 other manufacturers and wholesalers cooperate with the institute and conform to its policies.

The commission found that the institute and its members have conspired to confine sales and distribution of building materials to dealers recognized by the institute.

Practices from which the institute and its members are ordered to desist include the publication of lists of recognized and non-recognized dealers, the use of boycotts to prevent manufacturers and wholesalers from selling to non-recognized dealers, and cooperation with other dealer organizations and with manufacturers to interfere with the business of non-members.

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Cleveland Gets Grant To Widen Cuyahoga

The navigation channel of the Cuyahoga River, which winds a crooked course through the city of Cleveland, is to be widened and improved with the aid of a grant of $2,440,000 just made by PWA. The remaining cost of the $5,422,000 project is to be met by issuance of city bonds.

Since 1900, the lower 5½ miles of the Cuyahoga has had a navigable depth of 21 ft., but at sharp bends it will not pass boats more than 540 ft. long.

The project involves widening the navigation channel at critical places, cutting back the points and easing the principal bends. In addition, three old, narrow bridges are to be replaced.

The improved channel will have a minimum width of 200 ft. and a width of 250 ft. where the principal docks are located. Width around all bends will be such as to permit passage of boats 635 ft. long and 70 ft. wide. A new turning basin will be added to the existing two.

Construction plans for 10,000 ft. of new bulkheads and the replacement of the three bridges are now being prepared for early contract.

Vigilance is Urged Against Bad Plumbing

Seven hundred attend Boston meeting of New England Water Works Association

Resolutions pointing to the elimination of cross connection hazards and plumbing installations which might lead to water contamination were adopted by the New England Water Works Association at its annual meeting in Boston on Sept. 13-16. The resolution calls for the establishment of an authority in each municipality to pass upon the installation of fixtures and pipes, and requests the cooperation of manufacturers, engineers, and architects in preventing the use of improper plumbing equipment.

Honored by the association for his contribution to water treatment practice and particularly his paper on "Filter Bed Troubles and Their Elimination," was John R. Baylis, physical chemist, Bureau of Engineering, Chicago, who received the Dexter Brackett Memorial Medal, a yearly award made by the association. The presentation was made by Linn H. Enslow, editor of *Water Works and Sewerage*, and chairman of the committee on the award.

About 700 delegates attended the three-day convention at which 80 manufacturers exhibited their products. The technical sessions, which dealt with water supply costs, operating experiences, and special problems in supplying industrial and air conditioning needs, will be reported in next week's issue.

Officers elected for the coming year are: President, George A. Sampson, of Weston & Sampson, consulting engineers, Boston; vice-presidents, Percy A. Shaw, superintendent, Manchester, N. H. water department, and Leland G. Carlton, registrar, Springfield, Mass. water department; treasurer, Abel Reynolds, treasurer, New England Water Light & Power Association, Providence, R. I.; secretary, Frank J. Gifford, manager, Community Water Service, Dedham, Mass.

Gordon M. Fair, professor of sanitary engineering, Harvard University, continues as editor of the *Journal* of the Association.

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Three New Advisers On A.I.S.C. Board

Three new members have been appointed to the technical advisory board of the American Institute of Steel Construction. They are Charles Derleth, Jr., dean of the College of Engineering of the University of California; Otis E. Hovey, until two years ago consulting engineer for the American Bridge Co.; and Aubrey Weymouth, chief engineer for Post & McCord.

The technical advisory board of the A.I.S.C. is composed of thirty engineers, architects, teachers, and steel production and fabrication technicians. The board is intended to aid in the coordination and development of engineering technique relating to the design, fabrication and erection of structural steel.

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Private Construction Emphasized by C. of C.

Emphasis will be placed on the importance of private construction and its recovery at the Construction Industry Conference being held by the Chamber of Commerce and the Construction League of the United States in Washington Oct. 20–21, according to the program committee. It is intended to emphasize "the essentially local character of construction" and the need for coordination of local efforts.

The conference will direct attention toward promotional plans which groups in the industry have carried on to stimulate private construction work and is intended to provide opportunity for public discussion of the obstacles which need to be overcome to release the normal volume of private work.

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Preston Put in Charge Of Colorado-Big Thompson

Porter J. Preston, senior engineer for the Bureau of Reclamation, has been appointed supervising engineer of the $44,000,000 Colorado-Big Thompson reclamation project. Construction of this project will bring 320,000 acre-ft. of water annually from the head waters of the Colorado River under the Continental Divide to provide supplementary water supplies for irrigated areas in the South Platte River basin in Colorado.

Preston was in charge of the preliminary investigation work on this project and made the report which recommended that water stored in Grant Lake be diverted through a 13-mile tunnel under Rocky Mountain National Park rather than around the southern boundaries of the park.

Preston, now 68, has been employed by the Bureau of Reclamation since 1917 and has been senior engineer since 1931. He graduated from Colorado State College in 1892 and spent some years on various private reclamation projects.

Philadelphia Forms Sewer Authority

Public corporation will carry out $40,000,000 program of sewage treatment and water supply

Acting after considerable prodding by the Pennsylvania health authorities, the Philadelphia City Council on Sept. 13 set up a semi-public corporation, the Philadelphia Sewage and Water Authority, with power to issue bonds and carry out a $40,000,000 program of improvement to the city's sewage treatment and water supply system. Members of the authority are to serve without pay.

The state attorney general's office on Aug. 30 notified the city that unless it took some action toward treating its sewage before Sept. 22, the Pennsylvania Stream Pollution Act would be enforced against it (*ENR*, Sept. 15, 1938, p. 314; Aug. 11, 1938, p. 159).

A state law passed last year permits the financing of sewage works on a revenue bond basis.

Tentative plans of the new authority call for an expenditure of $29,800,000 on sewage treatment works and $7,000,000 on the water system. The authority expects to apply for a PWA grant of about $16,000,000, and preparation of preliminary plans is being rushed in order to meet the Sept. 30 deadline for PWA applications under the 1938 program.

The authority plans to carry out sewage treatment work amounting to about $8,000,000 at the existing Northeast sewage treatment plant. Here $5,000,000 would be spent on the plant and about $3,000,000 on intercepting sewers and other works. Another $8,000,000 is to be spent on a new southeast plant and $13,800,000 on a plant in the southwest section.

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PWA Refuses Payment On High Unit Bids

Asserting that the Pennsylvania General State Authority had been guilty of "disregard of simple prudence," the Public Works Administration disclosed Sept. 19 that it had refused to pay 45 per cent of the cost of excavation work on the Pittsburgh Psychiatric Hospital, a PWA project.

The requisition was based on an excavation item of $98,000. The work was held under general contract by Matthew H. McCloskey, on a unit price of $7.60 per cu.yd. PWA investigation showed that the excavation item was sublet for $4 per cu.yd., and the subcontractor then sublet for $2 to a third contractor who performed the work.

Weather Bureau Head Dies at Fifty-Eight

E. F. Chase was Seattle sanitary engineer—Freeland of Nashville firm dies

Willis R. Gregg, since 1934 chief of the U.S. Weather Bureau, died in Chicago Sept. 14 at the age of 58. Gregg entered the Weather Bureau in 1904, a year after his graduation from Cornell University.

After service in the observatory at Mount Weather, Va., Gregg became head of the aerological division in 1917, and in this capacity was active in developing a weather service for airplane use.

E. FRENCH CHASE, 62, city sanitary engineer of Seattle, died there Sept. 15. Chase had been with the city since 1907 when he started as an inspector in the city engineer department. In 1916 he was transferred to the department of streets and sewers as city inspector and later achieved the rank of city sanitary engineer, holding that post until the time of his death.

FRANCIS E. FREELAND, a member of the Nashville engineering firm of Freeland-Roberts, died in Nashville Sept. 9 at the age of 57. Educated at Daniel Baker College and Vanderbilt University, Freeland taught at Vanderbilt for three years after his graduation. Then in 1909 he became chief designing engineer for the Nashville Bridge Co. Five years later he entered private practice in partnership with W. H. Klyte and in 1918 formed the Freeland-Roberts Company.

MICHAEL KLASSAN, 87, a construction engineer active in the early days of Ventura and Los Angeles counties, Calif, died at Sawtelle, Calif. Sept. 13.

BOGUE VANDERCOOK, 61, former city engineer of Longview, Wash., died there Sept. 13. Vandercook was once a member of the engineering staff of the Long-Bell Lumber Co. and later superintendent of the Longview Portland & Northern R.R.

WILLIAM R. WHITTON, Seattle civil engineer, died there Sept. 8 at the age of 75.

WALTER H. MANSFIELD, until his retirement in 1926 industrial development engineer for the Delaware & Hudson R.R., died at Colchester, Vt. Sept. 10 at the age of 75. Mansfield began his engineering career in 1879 with the Boston & Providence R.R. He worked with various Boston engineering firms on elevated railway and sewer work and entered private practice in 1902. He joined the Delaware & Hudson staff in 1912 with the rank of assistant engineer.

WILLIAM MARTIN, SR. of Bridgeport, Conn., founder and for many years president of William Martin & Son, building contractors, died recently at the age of 78. He founded the Martin firm in 1893 and built many important structures throughout the state.

C. PARKER HOLT, vice-president and director of the Caterpillar Tractor Co., died Aug. 24 in Piedmont, Calif., at the age of 58.

CLIFFORD M. ALSTON, 55, Salt Lake City contractor, died there Aug. 16. Alston was for many years a member of the firm of Alston & Hoggan and was a former president of the intermountain branch of the Associated General Contractors.

FRED A. MILLER, honorary chairman of the board and former president of S. R. Dresser Manufacturing Co., died Aug. 22 at Bradford, Pa. Miller was 70 years old.

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Taxpayer Seeks Injunction On Ohio Road Contracts

An injunction to prevent the Ohio highway department from proceeding with 31 highway improvement projects involving the use of hot mix bituminous material is sought in a taxpayers' suit brought Sept. 13 by Agnes B. Dickinson, acting for the Ohio Citizens Tax Vigilance Committee. Mrs. Dickinson was recently successful in obtaining an injunction preventing the highway department from making payments on hot mix contracts allegedly let at excessive rates.

The new suit seeks to enjoin the letting of the projects at allegedly excessive cost estimates, the placing of high and low grade aggregates in competition with each other, and grouping of small projects in the territory of the Hot Mix Bituminous Industry of Ohio, Inc. The state highway director, four other highway officials, seventeen Ohio contractors listed as members of the Hot Mix Bituminous Industry of Ohio, and the state auditor are defendants in the action.

This suit, like the previous one brought by Mrs. Dickinson, rose out of charges of improper practices by the Ohio highway department in connection with the letting of hot mix bituminous highway jobs. These charges were made last spring before the Ohio legislature.

Oregon Retaliates On Licensing

State board will no longer recognize civil engineering licenses granted by California.

A civil engineering license granted by the state of California will no longer be recognized as sufficient qualification for receipt of a license from the state of Oregon. The Oregon State Board of Engineering Examiners made this decision in a resolution adopted last week.

The action of the Oregon board was taken after the California State Board of Registration for Civil Engineers announced that it did not recognize an Oregon license as qualification for a California license.

Interstate agreement

The states of Oregon, Washington, and Idaho last May adopted a reciprocal licensing agreement (*ENR* May 26, 1938, p. 730), and at that time the state of California was invited to participate in the agreement.

Replying to the invitation last June, Secretary H. M. Jones, of the California board, said that "this board holds that registration secured outside this state gives an applicant no higher standing than that possessed by one without previous registration." Jones said that the California board did not consider the examination given by the Oregon board comparable with the examination given in California.

Oregon law

In adopting its resolution, the Oregon board pointed out that the state law permits the board to accept a license from another state as qualification for an Oregon license only when that state grants equal reciprocal privileges to engineers who are registered in the state of Oregon.

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Asphalt Meeting Date Postponed a Week

The date of the twelfth National Asphalt Conference, to be held in Los Angeles, has been changed from the week of Feb. 20, previously announced, to the week of Feb. 27, 1939.

With the theme, "20 Years of Progress," the conference program will be based on the fact that 1939 marks the twentieth anniversary of federal aid for highways.

CALENDAR OF MEETINGS

See advertising page 40

LABOR NOTES

BROOKLYN painters ended a seven-day strike Sept. 8 when the Associated Painting Employers of Brooklyn agreed to renew an existing contract with District Council 18 of the Brotherhood of Painters, Decorators, and Paperhangers. The contract, substantially the same as last year's, provides for a 35-hour week, wage of $11.20 per day for a seven-hour day, and hiring of 50 per cent of employes from the unemployed list of the union.

THE CONNECTICUT state highway department is not opposed to its employees joining a labor union, Commissioner W. J. Cox announced, following reports that employees of the highway department are being signed up by the American Federation of Labor. "Neither membership nor non-membership," Cox said, "affects any employee's standing in the state highway department. . . . I see an opportunity for the union to perform a service both to members and to the state of Connecticut."

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A.F.L. Union Certified On Housing Project

Mechanical and electrical draftsmen employed by Red Hook Housing Associated Architects, architects on the USHA-financed Red Hook housing project in New York City, are to be represented in collective bargaining by the International Federation of Technical Engineers, Architects, and Draftsmen Unions, A.F.L. The New York State Labor Relations Board on Sept. 1 certified the Architectural and Engineering Guild, Local 66 of the I.F.T.E.A.D.U. as bargaining agent.

The guild has announced that it will begin negotiations with Associated Architects, seeking to obtain a scale of $70 for draftsmen, the scale to be retroactive to April, 1938.

The guild took the case to the State Labor Relations Board after the architects had refused to bargain with the union.

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Courses in Housing Offered by Union

Two courses in housing are being offered during the fall term of the Federation Technical School, sponsored by the Federation of Architects, Engineers, Chemists and Technicians, C.I.O. One of these courses is intended for experienced architectural and engineering draftsmen and designers specializing in housing. The other is a popular course for officials of labor and other organizations interested in public housing.

Students in the technical course will study the basic principles of design of large-scale housing developments, dealing with location, site planning, choice of type of building, unit planning, as well as various details of construction and equipment. Economic and social as well as technical aspects of these problems will be dealt with.

This course, which meets weekly in the evening, will be under the direction of John S. Stein and Henry S. Churchill. A registration fee of $3 and a course fee of $9 will be charged. The fall session begins Oct. 3.

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Heavy Construction Men Form The Moles Society

The Moles, a society of individuals actively or formerly engaged in heavy construction, tunnel, subway or marine work, has been formally organized with headquarters in Jersey City, N. J. The organization was founded by Alex M. Stagg, Harry A. Leeuw and Albert V. Sielke as a social and contact medium for both employers and employees.

One of the principal purposes of the society will be to provide means for construction superintendents, engineers, foremen, and skilled mechanics to find work and to enable construction firms to locate men they have lost track of temporarily. Other purposes enumerated in the by-laws include providing a means for exchange of construction information, cooperation in maintaining agreements, and a guarantee of loyalty and interest in each other's welfare between contractors and employees.

The organization will be national in scope through setting up of regional chapters. Several applications from interested groups throughout the country are already being considered. The New York Metropolitan group holds dinner meetings the first Wednesday of every month at the Great Northern Hotel in New York City. An all-day outing and clam-bake was held recently.

Headquarters of the organization are at 143 Ocean Ave., Jersey City, N. J., at the offices of the secretary, Alex M. Stagg, lumber dealer and former superintendent for the Degnon Const. Co. Other officers are: President, Harry A. Leeuw, Allan N. Spooner & Sons Co.; vice-presidents, Albert V. Sielke, consulting engineer, and Jas. H. Fitzgerald, Fitzgerald & Hudson; seargent-at-arms, Albert F. Geiger, Carleton Co.; directors, Ray N. Spooner, James F. Sanborn, Roy E. Ross, John S. MacDonald and Miles I. Killmer.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

CONSTRUCTION is expected to receive its share of attention during the coming inquiry by the National Economic Committee, popularly known as the anti-monopoly study. Studies are already being made to determine, if possible, why the construction industry has failed to respond to improved business conditions.

It is understood that a number of building supply industries, including steel, brick and tile, glass, cement, and plumbing and heating, are now under scrutiny. An effort will probably be made to appraise the effects upon construction volume of wage rates and the possibility of substituting an annual wage for hourly scales.

WITH MORE THAN ENOUGH applications on hand to use up its funds and more coming in at the rate of over a hundred per day, PWA has warned municipalities that failure to act promptly in accepting allotments will mean possible rescission in favor of other communities with projects ready to start. Such action has already been taken on 25 allotments.

PWA IS ALSO STUDYING unusually large projects very carefully, and in several cases a number of small undertakings in a state have been favored over a single large project. In particular, PWA has definitely decided against the big hydro-electric project on the Fox River in Wisconsin and has released 114 projects in the state involving grants totaling $8,512,000.

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Fellowship at Mellon To Study Meters

An industrial fellowship on meter technology has been established at Mellon Institute in Pittsburgh by Pittsburgh Equitable Meter Co. Among the first projects to be investigated is that of adapting synthetic plastics as construction material for liquid meters.

R. L. Wakeman has been appointed to fill the new fellowship. Wakeman, who holds a doctorate from the Massachusetts Institute of Technology, has been on the research staff of the institute since 1935. He has specialized on synthetic resins and plastics.

News continued on adv. page 36

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Inspection Often Neglected

Sir: Your editorial, "Worth Paying For," Aug. 25, p. 225, is very timely, and it is hoped will bear fruit, especially among our engineers upon whom is placed the responsibility for writing specifications, and also those whose duty it is to make the arrangements for inspection service.

The work of the inspecting engineer is fully as professional as is that of any other phase of engineering, and therefore subject to the same standards when it comes to making a selection for inspecting any particular piece of material or construction.

Unfortunately there is an increasing and notable tendency among those in charge of projects being planned to write into the specifications, a provision for inspection and then in that part of the inspection specification which relates to mill, shop or other manufacturing processes, and oftimes field work too, to specify that the inspector shall be employed by the contractor and paid by him, with provision in some cases that the inspector is to be approved by the engineer. In other cases the matter is left to the contractor. The result is that in either case the contractor is allowed to retain the person or firm who will do the job for the lowest price and with little if any regard to efficiency or experience.

The results are manifold:

First, the owner for whom the engineer plans the work and writes the specifications oftimes, does not get what he is paying for, as he ultimately pays the bill.

Second, the contractor too oftimes doesn't get what he thinks he is paying for and charging the owner.

Third, the person or firm retained to do the inspecting is compelled to go into "cut throat" competition to obtain work, with the result that the inspection is done at a loss, or else neglected to try and avoid a loss, resulting some times in a further loss to the owner and contractor.

And so one might continue almost indefinitely to cite reasons why there should be better and more adequate provision for efficient and thorough inspection of materials and workmanship.

But let us hope that there may come about a different view point, and that the inspecting engineer, as such, may again come into his own.

WILLIAM R. CONARD
Inspecting Engineer and Consultant
Burlington, N. J., Aug. 29, 1938

Sir: May I offer my congratulations on the editorial, "Worth Paying For," in this week's *Engineering News-Record.*

The specifications of the American Welding Society for the welding of bridges endeavored to emphasize the importance of inspection and the responsibility of the engineer and inspector, along the lines indicated in this editorial. It is probably however not the case that the average engineer or purchaser concerned with a welded building looks at this from the same angle.

It is certainly to be hoped that this editorial will be widely read and accepted, for it expresses a most important truth.

JONATHAN JONES
Chief Engineer, Bethlehem Steel Co.
Bethlehem, Pa., Aug. 29, 1938

Land Fill: Pro and Con

The following comments refer to the article, Land Fills for Refuse Disposal, by E. J. Cleary, which appeared in the Sept. 1 issue, p. 270.—EDITOR

Sir: It is refreshing, in an era of increasing mechanization of municipal waste disposal, to read of a group of sanitary officials and engineers that is sufficiently ingenious and independent of thought to find a simple, economical and beneficial method of refuse disposal in the modernization of the older, less spectacular method of sanitary fill. That this method can be made satisfactory has been abundantly demonstrated in England. It remained for the city of New York to show that it could be worked with equal success, and with greater economy than incineration, under the conditions existing in the largest American municipality.

There are two aspects of the problem that are of particular interest to the engineers. The first is that of the city rising anew, like the Phoenix, from its own ashes: waste lands, unsightly and often offering breeding places for mosquitoes, being converted into parks and attractive building sites and reclaiming the waterfront, one of the greatest assets of a community. The other is the sanitary and engineering management of the land fills: avoidance of odors, dust and paper storms, rat harborage, insect breeding and dump fires. It should be evident that the management of land fills, as practiced in New York, is an engineering undertaking that challenges the faculties of the engineer as fully as the design and operation of the most modern refuse incinerator.

GORDON M. FAIR
Professor of Sanitary Engineering
Harvard University, Cambridge, Mass.

Sir: I have personally been considerably interested in the land fill scheme of refuse disposal, as I believe it is an economical plan. Therefore, I am turning the article describing New York City experience over to the Commissioner in charge of the street cleaning department with the request that he make a study of the possible application of this method in Jacksonville.

W. E. SHEDDAN
City Engineer
Jacksonville, Fla.

Sir: Reclaiming marsh areas by garbage dumping can be accomplished without creating any nuisance. If by such a method the garbage can be disposed of at less cost than by incineration and if in addition new usable land can be created, then the method is of real economic value to a municipality.

In Larchmont the dump method of garbage disposal has been in effect since the village was founded many years ago. For the past ten years the dump has been on a marsh area of about 27 acres and at present about 20 acres have been reclaimed for park purposes which include baseball fields, tennis courts, recreation buildings and open park spaces.

After the garbage is dumped it is covered with about six inches of earth fill to remove unsightliness and odors and then later covered with

(Continued on adv. p. 40)

ENGINEERING NEWS-RECORD

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SEPTEMBER 22, 1938

THE ENGINEERING of the New York World's Fair is reviewed in this issue. In variety its range is much wider than would appear to be involved in such an undertaking, due chiefly to the peculiar characteristics of the site, a deep marsh filled or partly covered over with ashes of varying depths. Engineering problems began with the grading of the site, where great care had to be exercised to prevent formation of deep and long continuing earth movements. And, obviously, this soft ground brought with it special foundation problems, especially in the permanent or semi-permanent structures. These latter were placed on creosoted timber piles as best able to stand up under the attack of the products of decomposition of organic matter in the fill. For the temporary buildings, spread footings were weighed against pile foundations with interesting results. Anticipated settlement of the large exhibit buildings also raised interesting questions as to how best to minimize the effect of such movements. Similarly, in paving roads and streets and in installing services, unusual conditions growing out of the variable nature of the soil had to be met. Finally, the matter of transporting millions of Fair visitors to the grounds and inside the gates raised other and equally interesting problems to be solved. All these important engineering aspects are clearly set forth in the following pages. They warrant careful study by all who would get the most out of the Fair, for they will not be obvious to the engineer who visits the Fair next Spring.

Water Supply Yardsticks

MANY ARE THE DIFFICULTIES inherent in compiling comparative unit costs on water supply systems, as evidenced in a symposium on this subject at the New England Water Works Association meeting last week. Aside from the variations introduced by such factors as special local conditions and yearly changes in construction material and labor costs, it is evident that agreement is needed on the selection of fundamental units of measurement. For instance, should construction cost of a system be based on the unit of per-capita-served, or on a million-gallon-per-day-capacity? The first unit measures the cost on a service supplied basis, but it does not properly reflect the investment made for future demands; the latter, on the other hand, being in terms of total capacity will give a value which may vary widely depending largely on whether the system is overbuilt or underbuilt. One investigator reported that in a study of a number of surface water supplies using various methods of appraisal, the per-capita-served unit we found to be the most accurate basis of comparison. Further discussion on this obviously important matter of water supply cost compilation is worthy of the attention of the entire profession.

High-Pressure Construction

START OF CABLE SPINNING on the Whitestone Bridge at New York serves as a reminder of the fast construction schedule laid down for that important structure. From the time that foundations were begun in June of last year, 24 months is allowed to the opening date on June 1, 1939. Since the bridge and its approaches will cost $16,000,000, since the main foundations are sunk from 100 to 163 ft. below water level and since the main span of 2,300 ft. is exceeded only in the Golden Gate, George Washington and San Francisco-Oakland bridges, such a schedule demands an uncommonly fine planning and supervisory organization, a design that is simple and straightforward and contractors who know their business. Since the job is up to schedule after 15 months of work, all of these necessary elements apparently are present. Among examples of successful high-pressure construction, the Whitestone Bridge, it seems certain, is assured of high rank.

Incomes and Losses

SOME INFORMATION brought to light by patient Washington delvers into census figures throws interesting light on financial experiences in engineering and construction. A study of the national income by the Department of Commerce shows that contractors have been losing money at a rather heavy rate ever since 1929, and even in that busy year barely broke even; during six years (1929-1934) their losses were half a billion dollars greater than dividends. The construction worker's income during the same six years ranged from $1,763 to $1,108, and about two-thirds of the workers lost their jobs entirely—all this while the contractor himself was losing money with monotonous regularity. The consulting engineer's pocket nerve was hit almost as hard, this "industry" showing losses of 10 to 15 per cent in four years out of the six while its business dropped to 25 per cent of the 1929 level. The consulting engineer's own income fell from $10,000 to $3,500, the pay of his employee from $2,600 to $1,650. These figures are nothing to be proud of, but

they are welcome as giving us tangible facts on engineering and construction finances almost for the first time. The report does not say how many contractors and consulting engineers went on relief or into WPA work, but it is not hard to guess how many were tempted to do so.

New Terminals Needed

STATEMENTS TO THE EFFECT that railroads are losing a large part of their former profitable fruit and vegetable business, made before the U. S. Chamber of Commerce conference on transportations last week, came as no surprise to informed railroad men. Trucks are taking away the business because railroad equipment and terminals are antiquated and inadequate, according to a study made by the U. S. Bureau of Agricultural Economics. The railroads well know that their terminals are out of date, but since the turn of the century two forces have been working against the needed modernization. On the one hand, the Interstate Commerce Commission has throttled initiative of railroad management and on the other hand railroad bankers have played fast and loose with their financial structures. To bring the large amount of potential work represented by this terminal modernization to the point where it will create actual business calls for drastic action on the part of both Congress and the owners of rail road securities.

For Wider Dispersion

MUCH ENCOURAGEMENT is found in the increasing signs that the Public Works Administration is making a determined effort to get the widest possible dispersion of its funds. Wide dispersion of the funds means that individual allotments will be small but also that a larger amount of money will be turned into payrolls and purchases of materials and equipment within a short time.

Quite naturally, when the new PWA program was announced the proponents of large projects came forward with their applications for loans and grants. Some, like the Battery-Brooklyn vehicle tunnel at New York, were so large and would require so much time for construction as to raise question as to whether they could be completed by the deadline set by the PWA. Others, such as the Fox River hydro-electric project in Wisconsin, were of such magnitude as to absorb practically all the money that was available for work in Wisconsin; small projects in many towns where the work will be needed to meet unemployment conditions this fall would have been excluded automatically.

Though no formal announcement has been made, the big Wisconsin project appears to have been dropped from the PWA preferred list. This deduction is based on the fact that $10,000,000 has been allowed for numerous small projects in Wisconsin, indicating that preference has been given to small undertakings. Similarly, the Battery tunnel at New York appears headed for the sidetrack while smaller amounts go for such projects as continuing work on Boston's new water supply, including a large amount of land clearing, and Cleveland's river-straightening work, which can be broken down into many separate items.

To be successful in stimulating business by putting a large amount of new money into new construction while at the same time providing a large amount of employment, the PWA funds need to be put into work that can be started with few preliminaries and that can be attacked from many points. Close adherence to such a program may result in scrapping favorite projects of influential people, but the general public will benefit.

It Can Be Done

GOOD NEWS came from the public housing front last week in the form of an announcement from Alfred Rheinstein, chairman of the New York City Housing Authority, that the Red Hook project in Brooklyn will be built for $850 per room instead of the $1,250 allowed by the USHA. Since these figures compare with $1,500 spent for the Williamsburg development in Brooklyn, completed under the former program, the Red Hook costs reflect a truly remarkable advance.

Credit for this accomplishment in reduced construction costs (land and demolition costs are not included in the above figures) is rightly accorded by Mr. Rheinstein to Alfred Poor, the architect, and to Allan S. Harrison of the Authority and his engineering staff, but it is proper to point out that encouragement and understanding on the part of Mr. Rheinstein, himself an experienced contractor, played an outstanding part. Low-cost housing has long needed a champion, in an executive position, who would emphasize "low cost" as well as housing.

By bringing construction costs down to a reasonable figure, the New York City Housing Authority has greatly advanced the prospects for low rent housing. In the first place, promise is given that more people can be housed with the available USHA funds than was thought possible; or the subsidy can be reduced or the rents decreased on the same amount of housing. Finally, because private investment must be brought into the low-rent housing field if a real dent is to be made in slum eradication, demonstrated low constructions costs are a heartening development.

New York World's Fair 1939 Its Background and Objective

W. EARLE ANDREWS

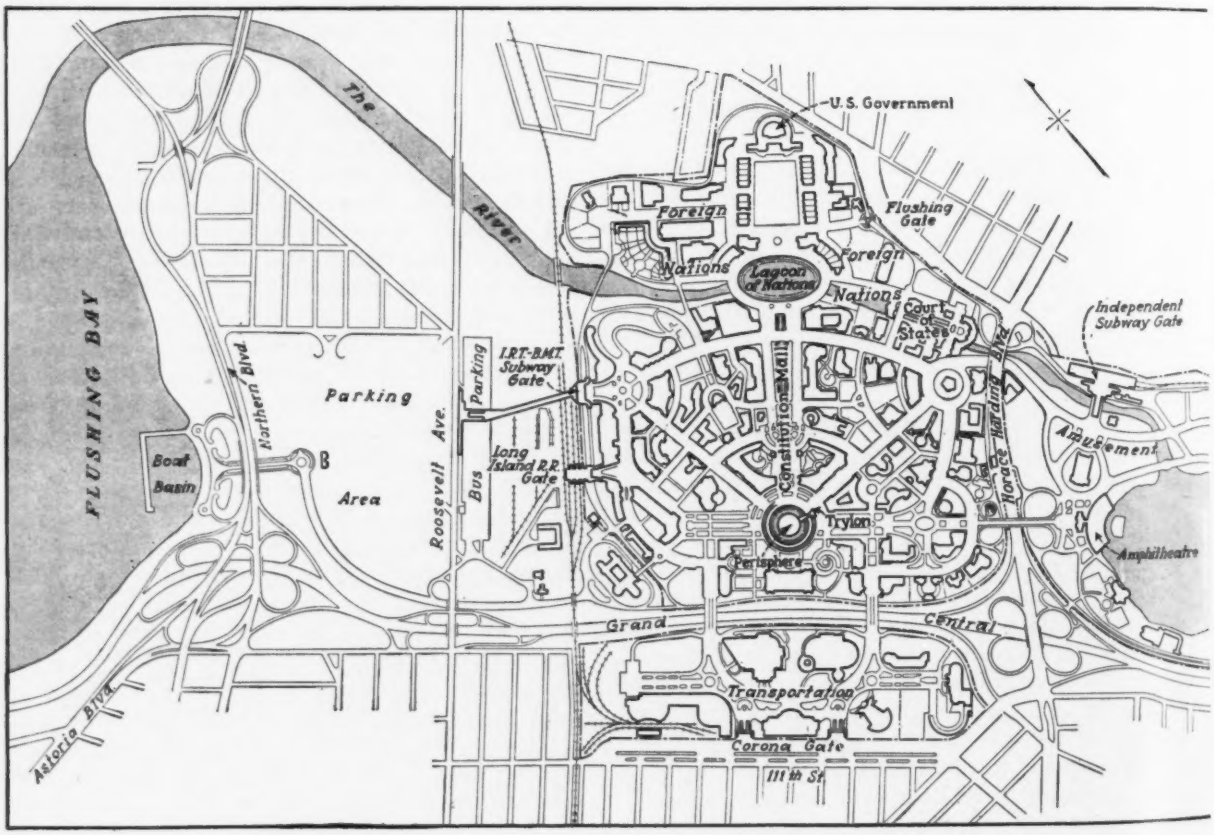
Consulting Engineer, Former General Manager, New York World's Fair 1939

Fair development, centered around the theme of "Building the World of Tomorrow," establishes new ideas in exposition planning

WHAT significance has the New York World's Fair for engineers? Is it something other than a costly aggregation of shells of buildings on which architects have been given an opportunity to get out of their systems a lot of ideas about what architecture of the future will be? This issue of *Engineering News-Record* is designed to answer these and like questions. The articles which follow were written by engineers and architects who are taking a major part in what will be seen to be a vast undertaking involving a surprisingly wide range of engineering and construction problems.

Before turning to the engineering work of the Fair it will be well to review some of the background and planning that resulted in the final determination to undertake construction of a Fair that will call for an investment of over $150,000,000 and will result in an expenditure by Fair visitors of an estimated total of one billion dollars.

The basic purpose of the Fair is to commemorate the 150th anniversary of the inauguration at New York of George Washington as President of the United States. That event could have been celebrated in many ways, but the fact that New York never has had a major fair made that type of celebration seem highly desirable. And as the possibilities of such a fair were explored it became evident that, if undertaken on a scale of sufficient magnitude, the fair could be an important factor in improving business conditions in

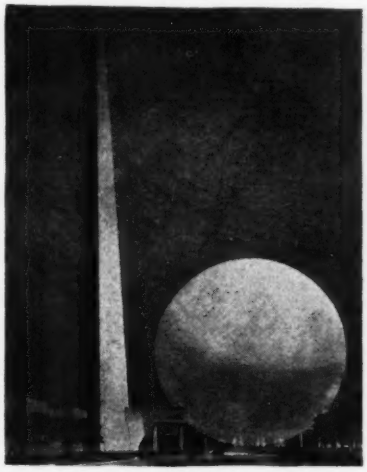


the whole New York area, and to some extent in the whole nation.

But a large fair called for a large site reasonably close to the center of the city and served by adequate transportation lines. At first, finding such a site seemed out of the question, but some study soon showed that the swamp area known as Flushing Meadows, and long used as an ash dump, might be made into grounds for the fair. The city already owned the greater part of the area, having acquired it in connection with the Grand Central Parkway project. The site lies close to the geographical center of the city and is served by rail and rapid transit lines as well as the parkway system of the city. To obtain the site a working agreement was made with the city whereby the Park Department bore the cost of grading and other basic improvements in the area and the Fair was provided with an unusually fine site and at the same time development of the site into a park was advanced by many years.

Once this decision had been reached, things began to move rapidly. By the spring of 1936 an organization had been formed, legislation at Albany had cleared the way for cooperation, both financially and otherwise, by both the city and state, and the New York World's Fair 1939 was under way.

The Park Department immediately began its nine months' job of moving and leveling 7,000,000 cu. yd. of ashes and meadow mat, and at the same time engineers and architects of the Fair's staff put their heads together to start the detailed plan of the exposition. The result of their



Theme Center of the Fair

deliberations was the Therme and Plan of the Fair, first published on Oct. 9, 1936, and never basically altered since.

The plan divided the Fair grounds up into three major areas, one for exhibits, one for amusements, one for government displays. Since it was felt that the exhibit area would be the most significant part of the exposition, this section was carefully plotted around a central Theme Plaza where the Perisphere, Trylon and Helicline are located. Zones were allotted to various phases of modern life such as production, distribution, transportation, shelter and food. It was felt that people could understand such an arrangement better than they could the arbitrary grouping of exhibits in halls of science, art, agriculture, and so on.

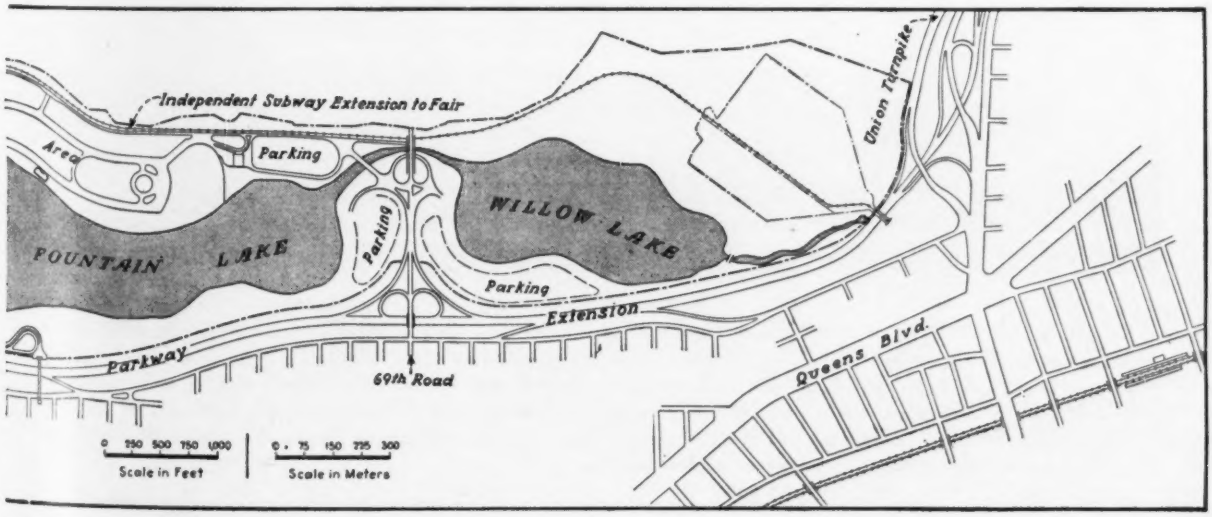
The theme of the Fair was given expression in the phrase, "Building the World of Tomorrow"—a slogan which, for the first time in the history of expositions, looked to the future instead of to the past.

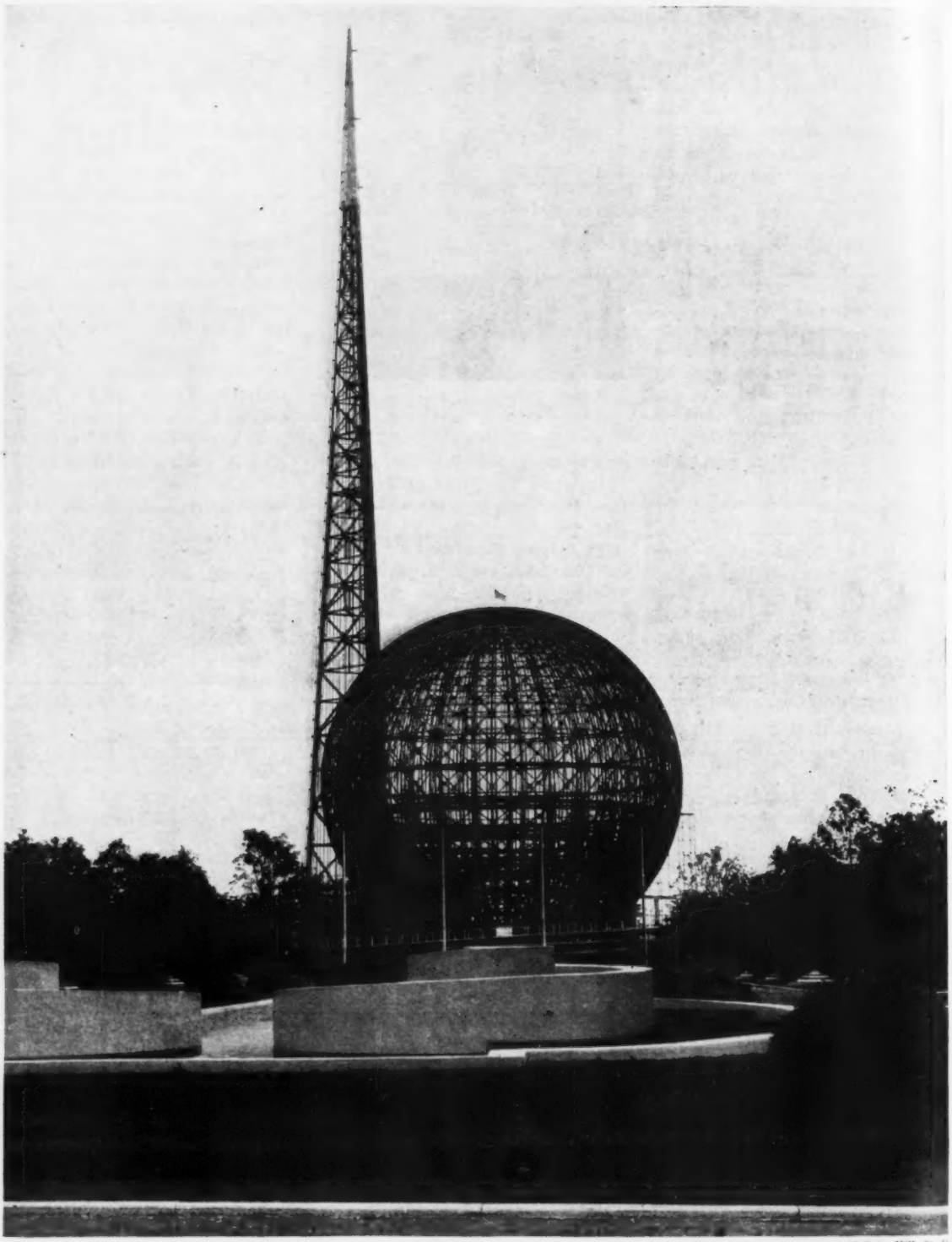
It was decided to give the theme of the Fair concrete reality in a central exhibit at the Theme Center.

Since the theme and plan were first made public nearly two years ago, we have watched them steadily approach realization. Advance financing was accomplished by means of a $27,829,500 bond issue, taken up by business and industrial firms. Design was placed in the hands of a Board of Design, through which all architectural and landscaping plans, as well as all murals and sculptures, are carefully filtered to see that all are in harmony.

The physical work of construction is progressing rapidly. Thousands of trees, shrubs and flowers have been planted; miles of roads, walks, sewers, mains and utility ducts have been laid; more than sixty buildings, including twenty great exhibit halls which the Fair corporation is erecting, are under way or completed.

Details of various phases of this gigantic task of building a $150,000,000 Fair can be read in succeeding pages of this issue. All that remains to be said is that the Fair staff is sufficiently advanced toward its goal to be able to state without qualification that the world will see a new type of exposition—one that not only entertains and thrills but gives instruction and provokes thought, an exposition unlike any ever attempted before—when the New York World's Fair opens its gates on April 30, 1939.





McGraw-Hill Studio

THE PERISPHERE AND TRYLON are the most interesting structures of the Fair from an engineering viewpoint, requiring unusual fabrication and erection procedure which will be described in a subsequent issue. The symmetrical steel skeleton of the Perisphere, which now stirs the admiration of all who see it, is to be covered with a thin shell of gypsum board surfaced with a magnesite compound. Similar surfacing will be used for the Trylon except at the top, which is of steel plate. Scaffolding for the surfacing work is now being erected; on the sphere it calls for cantilever arms to reach the upper surface.

ENGINEERING NEWS-RECORD, SEPTEMBER 22, 1938

FIG. I. THE ASHPILE 90 FT. HIGH THAT WAS CUT DOWN AND LEVELED TO FORM THE FAIR SITE

Preparation of the Fair Site

CARLTON S. PROCTOR

Moran, Proctor & Freeman, Consulting Engineers, New York

Soft nature of much of the site made unusual care necessary in handling the filling material to avoid formation of mud waves

LYING ALMOST at the geographical center as well as at the center of population of Greater New York, Flushing Meadow, the site of the New York World's Fair, covering approximately 1,200 acres, was a marine swamp, built up of organic clays and silts extending to depths of 60 to 80 ft. below the surface, which lay at an elevation of only one or two feet above mean high tide level.

Flushing Meadow extends in a general north and south direction from Forest Hills on the south to Flushing Bay on the north. Near the southerly end the meadow has a width of around 2,000 ft., while near its northern extremity it has a width of over a mile. Underlying the entire area of the meadow is found a floor of firm sand and gravel which varies in depth below the surface from 15 to 20 ft. at the south to 70 and 80 ft. near the north end. This firm material rises to the surface along the east and west margins of the meadow, continuing on upward to form the hills and high ground along each side. Flushing River, a sluggish tidal stream, starts at the southerly end of the meadow as a small drainage ditch and, before its route was altered, followed a twisting course, winding back and forth across the meadow until reaching its outlet at Flushing Bay as a sizeable and navigable stream.

For over 30 years the city utilized the area between Horace Harding Blvd. and the Long Island R.R. as a city dump, and during this period 50,000,000 cu. yd. of ashes were dumped over an area of about 340 acres. The ashes at one point had a total depth of 125 ft. and in places the weight of the pile forced the meadow surface downward 30 to 40 ft. below its original level. Around the periphery of the ash pile large displacements of the underlying silt were evidenced by extensive mud waves and lateral movements of considerable extent.

Prior to any decision to develop Flushing Meadow, an engineering investigation was made of the entire area by means of soil borings and laboratory tests of soil samples. This original soil investigation included about 60 soil borings, spaced about 1,000 ft. each way, 13 being 4 in. in diameter to permit the taking of undisturbed samples for laboratory investigation. In addition, two field tests provided a practical demonstration of the behavior of the soft ground when loaded by various depths of ashes. Maps were available, prepared by the topographical bureau of the Borough of Queens, showing the surface topography of the entire area. The boring records, even though the borings were widely spaced, made possible the plotting, with a fairly close degree of accuracy of contours showing the elevation of the sand floor underlying the meadow, and the general determination of the depths to which the hills of ashes had been forced into the underlying soft silts.

Laboratory studies determined that

the soil forming the natural meadow consists of silt and clay containing two to three parts of water to one part of solids. The soil has a low load-bearing capacity and when disturbed or remolded becomes extremely soft and unstable. Both laboratory and field loading tests indicated that the natural meadow ground would sustain without displacement or remolding, a load of approximately 300 lb. per sq. ft., equivalent to about 4 ft. of ashes, and that slopes of embankments and fill grades should be limited to about 3 per cent to insure against the creation of mud waves during the placing of fill. Soil consolidation tests showed that settlements, or consolidations of considerable magnitude would result from the added weight of fill and that all soft ground areas must be filled to levels sufficiently above the desired finished grades to compensate for the expected settlements.

Effect of mud waves

Investigations of 24 structures constructed on the meadow in past years developed the fact that difficulties had been encountered due to the creation of mud waves when placing fills and embankments with ordinary slopes, and that serious movements of pile supported structures had been induced by deep earth movements, both lateral and vertical. Early in the original soil investigation it became evident that the major consideration in a grading and foundation program, lay in the prevention and control of lateral soil movements, to preserve the inherent "structure" of the clay-silt deposit

Fig. 2. Powerful tractors operating bulldozers both spread and compacted the fill.

and to prevent serious mud-wave flow.

Improvement of the meadow for a site for the World's Fair, and later for a public park for the City of New York, involved the filling of all the low lying areas to elevations above water level sufficient to insure dry ground and permit of suitable planting, most types of trees requiring a soil well above permanent water level. The material most suitable and economically available for grading was the great accumulation of ashes, extending to a maximum of 90 ft. above the swamp level. It was estimated that 6,000,000 cu. yd. of ashes could be removed from the dump area and would provide sufficient material for grading purposes.

Various studies were made to determine the most economical method for handling and distributing the materials over the soft ground. Inasmuch as laboratory tests had indicated that the soil, if disturbed or remolded, would consolidate and settle under load very much more than if undisturbed, it was necessary to place the fill in such manner as to prevent disturbance and remolding of the soil, which would be evidenced by displacement and the creation of mud waves. To accomplish this it was decided that the first layer of ash fill should be advanced with a depth of 4 ft., the remaining fill to be placed in one or two subsequent layers. Subsequent experience showed that a preliminary blanket, 4 ft. deep, was sufficient to support heavy trucks and other equipment and did not induce mud waves.

Handling excavation and fill

The following methods of handling the excavation and fill were studied:

(1) Hydraulic dredge method, pumping ashes to the fill areas.

(2) Loading industrial cars and moving cars over rails to the dumping points.

(3) Moving and distributing by belt conveyors.

(4) Distributing entirely by automobile trucks.

The hydraulic dredge method, while offering the advantage of large daily capacity and low unit cost, presented certain serious objections, among which were the loss of a considerable volume of ashes which might escape as fines in the sluicing water and, more important, the creation of a wet condition over an area already containing an excess of water. It was considered that any method involving the use of water might render the ground unsuitable for use for a long period after placing the fill.

The industrial car and railroad method proved not feasible, as pile

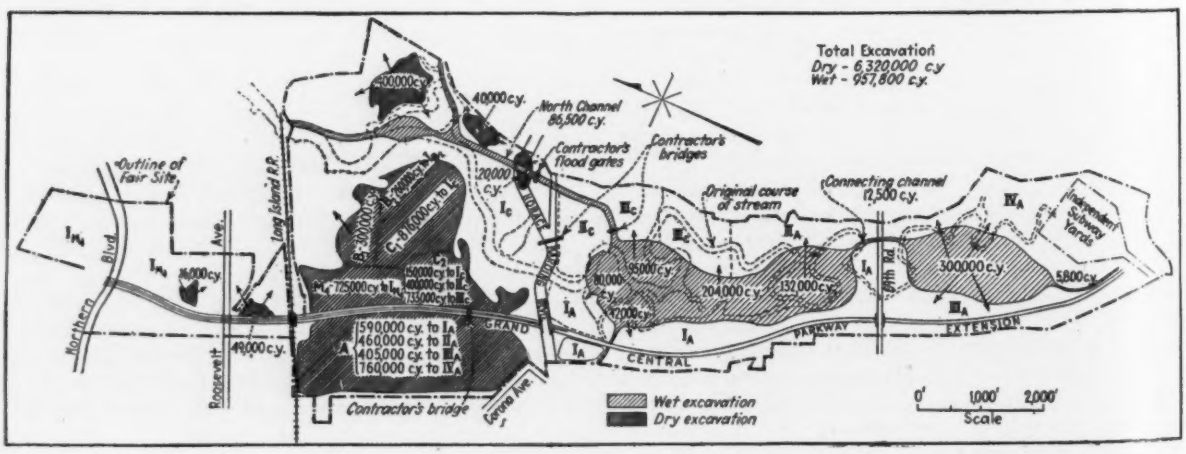


Fig. 3. Before grading started the contractors laid out this plan for minimizing earth movements.

trestles would be required wherever cars were moved over the soft ground, and the cost of trestle construction appeared prohibitive. The conveyor method, consisting of loading conveyors by steam shovels and conveying directly to the dumping points, seemed to provide flexibility of operation, but inasmuch as the cost of the conveyors, not readily salvageable, would have to be charged against the cost of the work, the method proved more expensive than the one finally adopted.

The all-truck method appeared to be the most adaptable of all those studied. Trucks could transport materials to any point desired without any delay for relocation of distributing equipment. Light trucks could be used where soft-ground conditions prohibited the use of heavier ones. With a multiple truck system there could be little or no danger of major delays due to breakdowns, and the necessity for expensive standby equipment would be eliminated. Trucks are available in the New York district in large numbers and, should additional trucks be purchased, they would have good salvage value. From point of complete flexibility of operation and economy of cost this method appeared to have the advantage over all others considered.

Work started

The grading contract was awarded on June 15, 1936, the contract requiring the completion of the work on April 1, 1937, allowing a total time of about 42 weeks for the work. The contract called for the grading of all low lying areas to various elevations, running from 4 to 10 ft. above the swamp level. The high ash pile lying between Horace Harding Blvd. and the Long Island R.R. was to be cut down to form a rounded mound having its top at about El. 24. The grading plan showed two sets of contours, one for the contract grade and one for the ultimate grades after settlement, these latter varying from a few inches to several feet below the contract grades. The contract included the excavation of two lakes, one about 4,500 ft. long, lying between Horace Harding Blvd. and 69th Road, and another about 2,500 ft. long lying between 69th Road and the car barns of the Independent Subway at Forest Hills.

The grading contract involved the excavation of about 6,000,000 cu.yd. of ashes from the old dump area, transporting this material for an average distance of 4,000 ft., and distributing it to the established grades, over soft ground. The excavation from the two lakes and the stream channel changes amounted to about 1,000,000 yd., to be performed coincidently with the other work.

Shovel cuts limited

In order to preclude the possibility of any soil movements due to excavations in the borrow pit, the height of shovel cuts was limited, the specifications stating that "The excavation shall be made in uniform layers not exceeding 10 ft. in depth." The specifications were rigid in the control of filling operations, requiring the fill to be placed in layers not exceeding 4 ft. in depth, with second and subsequent layers following a sufficient distance behind the first layer to prevent subsoil disturbances. In general it was specified that no upper layer of fill should advance closer than 100 ft. to the face of the previous layer, and for the first layer no single unit of equipment used should exceed 10 tons gross weight.

Contractor's plant

The grading contractor made a careful analysis of the work before starting operations in the field, his plan of operations being to excavate in the borrow area with gasoline shovels, load auto trucks, distribute to fill areas with trucks and level off the dumped material with bulldozers. The contractor's plant included the following main items of equipment:

- 8 1½-cu.yd. crawler-type gas shovels equipped with 2¾-yd. dippers.
- 5 1½-cu.yd. draglines equipped with 70-ft. booms and 3-yd. buckets.
- 14 bulldozers.
- 3 whirley cranes for general service.
- 76 rear dump trucks, 7 to 8 cu.yd. capacity.
- 20 13-cu.yd. bottom dump trailer trucks.

With the above equipment a production of around 200,000 cu. yd. was maintained for a 5-day week, except during periods of bad weather. Some trouble was experienced in certain borrow pits due to accumulations of organic matter which generated heat sufficient to occasionally cause cuts to burst into flames, and much of the material that was sent to the grading areas was smoking hot. Evidence of this heat in the ash pile was discovered during the making of soil borings when hot water was jetted to the surface in several locations.

The draglines operated around the edges of the lakes, working on heavy timber mats 24 ft. wide by 36 ft. long. The excavated muck was loaded and transported to points remote from the lake areas and dumped where, under a separate contract, it was to be worked over and processed to make it suitable for top soil. Trucks handling excavation from the draglines, because of soft ground conditions, traveled over roads constructed of timber mats. The utility cranes moved these mats to new locations as road changes were required.

The work was carried on for three shifts, five days a week. To facilitate night work an elaborate flood lighting system was installed, consisting

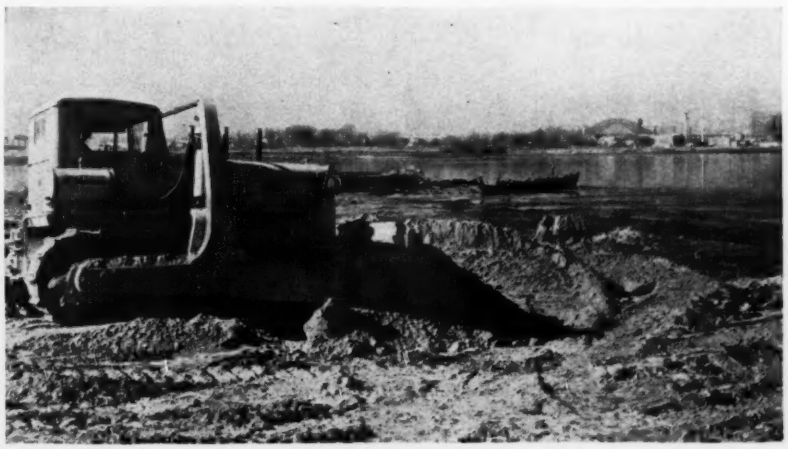


Fig. 4. Filling material was spread in thin layers over soft ground to avoid formation of mud waves.

of steel pipe towers about 80 ft. high, each being equipped with 20 to 50 1,500-watt lights, backed up with special reflectors. In addition to the flood lighting, local lighting was also provided around the operating units and along roadways.

Fill shrinkage

After grading operations had proceeded for several months, it was found that the volume hauled from the borrow pit was yielding less fill than expected. An investigation determined that the placed fill was being considerably consolidated by the action of the heavy equipment traveling over it, so that the volume of the fill was running from 65 to 70 per cent of the volume measured in the borrow pit. The ash pile was porous and spongy, with occasional cavities, due to some extent to past fires in the dump, whereas the placed fill, under the action of rolling equipment, was found to be densely packed so that it could not be easily excavated with hand shovels. It was practically impervious to moisture, rain water being retained on filled surfaces until it evaporated. Because of this shrinkage an adjustment was found necessary in grades and some additional fill was required after the termination of the general contract for grading the site.

In general the grading program was carried out as planned without creating soil movements except in a few localized spots. In a few locations, where movement of the ground became evident, soft spots were blanketed over with a light layer of fill, after which there was no more trouble. The old river channel north of Horace Harding Blvd. had depths running from 10 to 16 ft., and in two or three places, when the fill approached the river bank, slides or bank failures occurred.

Special structures

An important element in the preparation of the site, apart from the grading, was the construction of a tide gate and dam on the main river channel 300 ft. south of the Long Island R.R. by the city under the direction of the Park Department engineers. The dam was designed with its crest at El. 1.5 so that the water can be maintained at this level throughout the entire length of the site south of the dam. Swinging tide gates were installed on the crest to prevent the influx of salt water when the tide is above the crest level, the gates being balanced so as to permit the discharge of fresh water from the meadow when the tide is below crest level.

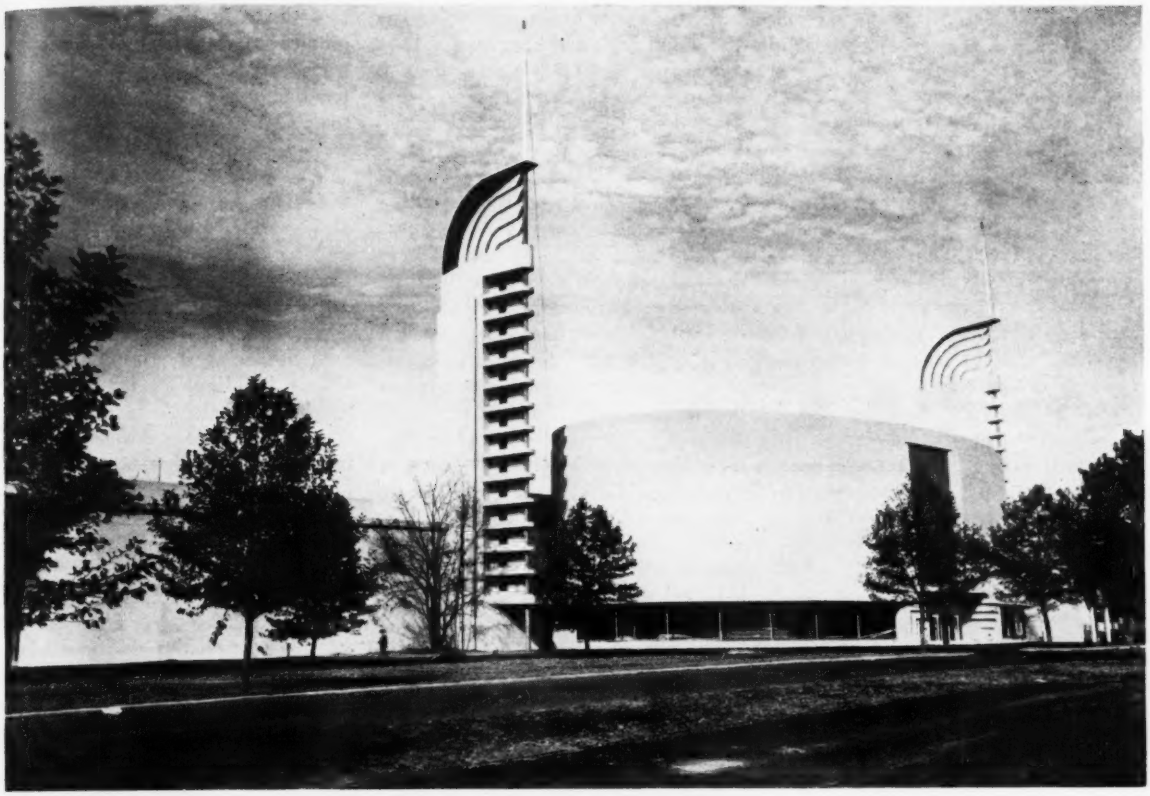
Permanent bridges designed by the Park Department were constructed by the state over the new stream channel where 69th Road and Horace Harding Blvd. cross the meadow. For a length of 400 ft., 200 ft. up and down stream from the bridge centers, the new stream channel is confined within bulkheads constructed of vertical interlocking steel sheetpiling driven to the sand. The sheeting is braced with timber, lying just beneath the channel bottoms, and the tops of the sheet pile bulkheads are capped with timber at the established water level. The new stream channel was necessarily completed before the old course was closed off and filled. The state also installed permanent bridges over the East Service Road to the Grand Central Parkway at Northern Blvd., Roosevelt Ave. and the Long Island R.R.

Under plans prepared by the park department, the state also built a boat basin with an access road at the south end of Flushing Bay, and the city, through the park department, installed a rock filled bulkhead along the entire south shore, back of which new fill has been placed to create park area which will be planted and landscaped.

The city installed marginal sewers on the east and west sides of the fair site, built the new Northern Blvd. double-leaf bascule bridge over Flushing River and is bringing into the Fair an extension of the Independent Subway.

The grading contract was handled by the Arthur A. Johnson Corp. and Necaro Co., Inc. of New York. Development of the site was under the jurisdiction and direction of Robert Moses, commissioner of parks for the City of New York.

Fig. 5. Trucks delivered the fill to bulldozers working on the edge of the fill.



THE TRANSPORTATION BUILDING DOMINATES THE WESTERN END OF THE AXIS OF THE EXHIBIT AREA

Adapting Plans to the Site

S. F. VOORHEES

Chairman, Board of Design, New York World's Fair 1939

Ground conditions and future use of the Fair site as a park were controlling factors in planning the layout of the grounds

THE TASK of the Board of Design began with a piece of land—some 1,250 acres—which though it was near the center of Greater New York had never been developed in any way. Planning for the best use of this site had to be undertaken with two different though not incompatible objectives in mind. The first was the needs of a temporary institution—the New York World's Fair 1939—and the second was the requirements of a permanent institution—the Flushing Meadows Park, which is to occupy the site after the Fair has been demolished. The plan adopted for the Fair then was made in close cooperation with the engineers and landscape architects of the Park Department so that, as far as possible, the Fair could take advantage of permanent improvements to be made for the park and could on its side leave as much of permanent value as possible.

Form of the Fair site

The site is a strip of land approximately three and one-quarter miles long and about a mile wide at its widest point. It is roughly wedge-shaped with the wide end nearest to Flushing Bay. The plan adopted for the Flushing Meadows Park called for two small lakes in the narrower end of the site, to be fed by the Flushing River. The desirability of placing the Amusement Area of the Fair adjacent to water, combined with the need for a larger unencumbered expanse of land for the Exhibit Area, made entirely natural the present division by which the two central sections of the four into which the Fair site is divided by the major highways which cross it are devoted to exhibits and entertainment. The outlying sections quite naturally became parking fields, once the use of the other sections had been determined. The Exhibit Area is known as Section One.

The decision to divide the site and allocate Section One to exhibits and Section Two to entertainment, as will be seen from the map on p. 350, was aided by another factor which is most important in planning a Fair—that is, the available means of transportation. It was evident that the proportion of visitors who would come to the Fair on foot would be very small. The overwhelming majority would come by one of the several low-fare railroad or subway systems. The northwest end of the site is cut by the elevated tracks which are operated jointly by the I.R.T. and the B.M.T. rapid-transit systems. This is a direct line from Times Square and studies by Fair engineers indicated a probable hourly peak of some 40,000 passengers. Also at this side of Section One is the Long Island R.R., which it was estimated could bring some 18,000 people per hour. The flow of visitors from this side was balanced by a similar flow from the station of the Independent Subway System which is near the division between Section One and Section Two. Smaller hourly peaks, probably 15,000, were expected to be brought by the surface transportation systems to the Horace Harding Blvd. Gate between Section One and Section Two. The Corona Gate, southwest of the Grand Central Parkway, was arranged for motor buses and taxis and hourly crowds of approximately 10,000 were estimated. It was natural to place the main Exhibit Area between these various entrances to the Fair.

Street and road layout

The layout of streets and roads in the Exhibit Area will be seen to be adapted to the conditions the Board of Design had to face. Symmetrical as it is, it is not a result of subservience to tradition but a solution to the problem imposed. Each of the main entrances—and it will be noted that there are several main entrances, a single grandiose main gate having been avoided—leads to an open plaza. From each plaza there are several arteries with attractive vistas. Thus it is hoped that crowds will be diffused and scattered through the area.

The type of planning which is wise for a museum or for more organically related material, is not practicable at a fair. It is not possible to lay down a scheme by which visitors will be led in a preconceived order from one exhibit to another. The Fair has, in conformity with its theme, attempted the maximum logic and meaning in the arrangement of the Exhibit Area; it has divided the area into several sectors, one devoted to shelter and community interests, one to food, one to transportation, and so forth. It is not possible, however, to set up on the scale of a World's Fair a rigidly controlled system of circulation.

The condition of the ground on which the Fair was to be built had also to be taken into consideration in making plans. The land near the Flushing River was extremely soft. The river itself was confined to a channel and a tide-gate installed. The area bordering it was used for such lighter buildings as the demonstration houses in the Town of Tomorrow, while the buildings devoted to heavy industry and railroads were placed on the higher firm ground at the southwest side of the site. Approximately the highest point was occupied by the Perisphere and Trylon of the Theme Center. The exhibits devoted to transportation made a natural unit for the area on the southwest of the Grand Central Parkway. The two bridges built for ultimate park use are being doubled in capacity by temporary additions.

To sum up the plan of the New York World's Fair 1939, it will be expressed as being definitely in a developed park instead of being a Fair within a city surrounded by high buildings.

The amphitheatre at the north end of Fountain Lake is a permanent structure of steel and reinforced concrete that will form part of the equipment of Flushing Meadows Park. Waterproofing of the concrete steps is in progress in the foreground.

Construction Organization and Technique

JOHN P. HOGAN
Chief Engineer and Director of Construction, New York World's Fair 1939

Speed and flexibility obtained by a straight-line organization in which coordination is provided by a general staff

THE NEW YORK WORLD'S FAIR is primarily a city for the accommodation of a million people in which everything but shelter must be provided. Its construction therefore involves all branches of municipal engineering, architectural construction, exterior terminals for rapid transit and buses, internal transportation, bridge construction, landscape engineering and utility construction and management for light, power and water supply. Finally the construction involves the execution and the application or erection of a large amount of mural paintings and sculpture. In all of this work there has been the desire that the greatest variety of structural design should be permitted consistent with preserving the harmony of the whole.

It is obvious that a complicated problem of this sort could not be solved by a simple straight-line organization. The principle finally adopted is similar to that of the army with separate straight-line organizations employed in simple execution coordinated by a strong general staff.

Board of design

At the head of the entire design program is a Board of Design which prepares all general plans, basing its determinations on the physical facts, technical studies and estimates of cost prepared by the Construction Department and subject to the budget control of the latter. The Board of Design also prepares detailed plans for layout, landscaping and lighting of the Fair and preliminary architectural plans for numerous miscellaneous structures which are too small to merit the services of a contract architect. The board is made up of Stephen F. Voorhees, chairman; Gilmore D. Clarke, William A. Delano, Jay Downer, Robert D. Kohn, R. H. Shreve, and Walter D. Teague.

Architectural designs

The architectural designs of buildings, in general, are prepared by architects or groups of architects employed under contract. The Board of Design selects all contract architects, sculptors and painters and criticizes and approves their work. It also maintains a number of consulting advisors on various technical details—architecture, painting, sculpture, lighting, etc. During the preliminary stages of design by contract architects and approval by the Board of Design, the Construction Department also exercises cost control through the board. When the design by the contract architects on the staff of the board has reached a definite stage—that is when the size, form, character and the architectural treatment has been definitely determined and the cost approved by the Construction Department—the project is turned over to the Construction Department for the preparation of working drawings and the execution of the project. This includes the working out of all architectural details which are resubmitted to the Board of Design for final approval when the working drawings have been completed. Actually a very close liaison is maintained between the staff of the board and the architectural-engineering staff of the Construction Department throughout the progress of the working drawings, and where radical changes are required the contract architects are called back into consultation. The foundation, structural, electrical and mechanical designs are prepared by the Construction Department.

Engineering projects such as water supply, paving, sewers, electrical distribution and drainage are initiated and carried to completion in the Construction Department. Other engineering projects such as bridges are initiated in the Construction Department and are referred to the Board of Design for architectural criticism. The Board of Design and the Construction Department also maintain a close liaison on materials of construction and cost.

Army-type organization

The Board of Design, therefore, is very similar to a war council in a military organization, initiating the general plans and criticizing the detailed plans of the field organizations but not exercising administrative control.

The organization, due to the diversity of the work being handled in the many branches, also has a staff organization which might be likened to that of an expeditionary force or an army in the field. The staff actually consists of an architectural section with a staff of designers and draftsmen under a chief architect, Irvin L. Scott; an engineering section under the assistant chief engineer, L. B. Roberts, which comprises an electrical branch, a mechanical branch, a sanitary section, a structural and foundation section, a material branch, a cost section, an accounting section and an executive and personnel section. Landscape work is under the direction of Henry Nye, chief landscape designer. Finally there is a section dealing with construction needs of exhibitors, which will eventually be merged with the Operations Department of the Fair corporation, and a technical section which administers the World's Fair's own building code.

This department is similar to the building department of a municipality. It works in close liaison with the exhibit section and the permits section of the general manager's department.

Construction divisions

In the field, due to the diversity of the work, it has been found necessary to establish four divisions—building construction, engineering construction, road construction and surveys. The latter section serves all three of the field groups, and the work of all four is coordinated by the assistant chief engineer. These field divisions also perform a certain amount of maintenance and operation during the construction period, which will gradually be turned over to the operating department.

Building Construction—This section supervises the construction by contract or builds with its own forces the superstructures of all World's Fair exhibit buildings including lighting and mechanical equipment, all street lighting, exterior building lighting and electrical supply work, including conduits and substations. At present it maintains all structures, maintains and operates the power and light system and operates the water supply.

Engineering Construction—This section supervises the construction by contract or builds with its own forces the bridges, water supply, the sewerage system, the storm drains and the foundations of World's Fair structures. It maintains the landscaping, water supply and temporary and permanent roads. All grading and landscaping on the site is done by direct labor under this section.

Road Construction—This division supervises all road construction done by contract. It has no laboring forces and any roads built directly by the corporation or any special foundation problems are handled by the engineering division. The establishment of this division was purely a convenience and was adopted as a measure of relief to the engineering division on account of the vast amount of paving to be done in the relatively short time allotted. Were it not for this fact it might well be a part of the engineering division.

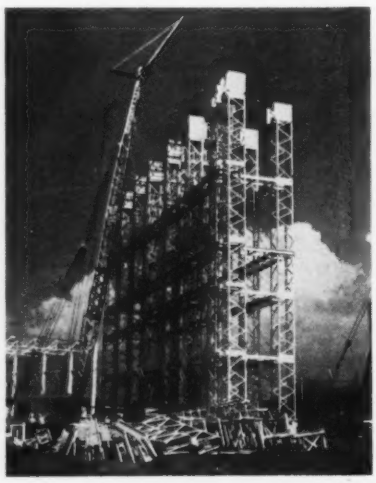
Surveys—The limitations of time and the great volume of work made it necessary to divide the construction work into several divisions and required the establishment of an independent survey division in order that the twenty field parties might be switched at will from one part of the work to another as pressure developed. Furthermore, in the early stages, when the site was becoming stabilized, the maintenance of survey points generally throughout the area was a difficult task and one requiring close coordination.

Design staff organization

The organization of the design staff of the department along functional lines with staff control was in a large measure dictated by the diversity of the problems. Another contributing factor was the desire to avoid too many small groups. For example, design of structural steel and foundations for both architectural and engineering structures is carried on by a single group.

Mechanical work, plumbing, air-conditioning, ventilating, etc., is of primary importance in the buildings and is also of the greatest importance in the design of fountains and other structures. Therefore a single mechanical department is used for both with staff coordination.

These examples could be multiplied but the main effect is that by permitting concentration in the various branches on immediate requirements it is possible to cut down the time schedule on controlling projects. This is of vital importance since the Construction Department neither controls the program nor the architectural design.



Steelwork for the federal building

The engineering and architectural forces engaged in design layout and supervision of construction and administration in the Construction Department have ranged in number from 250 to 400. The direct labor force of the corporation employed in construction has varied from 400 to 600, and employees of contractors of the corporation numbered about 3,000. Other thousands of skilled laborers are working for exhibitors.

Enginering staff

In charge of work under the chief engineer are the following: L. B. Roberts, assistant chief engineer; J. P. McInerney, superintendent, building construction; Henry Welles Durham, engineer in charge of roads; E. J. Carrillo, superintendent, field construction; J. F. Murphy and L. F. Henshaw, assistants to the chief engineer; P. L. Langworthy, code engineer; E. M. Pratt, cost engineer; H. A. Foster, chief, engineering design; H. A. Magoon, chief, architectural design; P. A. Strobel, chief, structural design; Benjamin Eisner, chief sanitary engineer; S. R. Apt, chief mechanical engineer; H. W. Odell, assistant superintendent, building construction; Joseph B. Wood, assistant superintendent, field construction.

B. R. Value, who served as assistant to the chief engineer during the early stages of the work, is now director of transportation reporting to Grover Whalen, president of the Fair corporation.

The following engineers and engineering firms are acting in a consulting capacity in the design of engineering features:

Foundations—Walter J. Douglas, Lazarus White, N. A. Richards, Moran, Proctor & Freeman: Transportation—Robert Ridgway, Daniel Ryan, John C. Evans, Parsons, Klapp, Brinckerhoff & Douglas: Structures — Shortridge · Hardesty, Purdy & Henderson: Mechanical Equipment—Meyer, Strong & Jones: Electrical Distribution—W. H. Sawyer, J. D. Whittemore: Docks—Victor Anderson: Roads—Madigan-Hyland: Acoustics—Clifford Swan; Electrical Research Products, Inc.: Building Code—Victor Cucci, Bernard Gilroy, Edward J. Sullivan, William Wilson.

FIG. I. THICKLY CLUSTERED CREOSOTED PILES FOR THE THREE FOOTINGS OF THE TRYLON

Foundations on Deep Fill

H. ALDEN FOSTER
Chief of Engineering Design, New York World's Fair

GEORGE W. GLICK
Moran, Proctor & Freeman, Consulting Engineers, New York.

Spread footings or long piles used depending on the character of the underlying fill as revealed by soil and bearing tests

WHEN the Flushing Meadow Park site was turned over to the Fair corporation, the best available foundation information was secured from the report made to the Park Department of the City of New York in 1936 by Moran & Proctor, consulting engineers; from investigation previously made by the same firm for the foundations of the five permanent bridges, boat basin and tide gate; and from the experience gained during the grading of the site in 1936 and 1937.

The report to the Park Department on the general investigation of the site developed the fact that Flushing Meadow is a marine marsh formed of organic silt and clay, below which are various strata of firm sand, sand and gravel, and clay extending to bed rock some 400 to 600 ft. below sea level. In certain areas beds of peat up to 15 ft. thick separated the silt from the underlying sands. The top of the sand bed, upon which the clay and silt deposit rests, is at varying depths, reaching a maximum of approximately 70 ft. at the center of the area along the north and south axis. In the section lying between the Long Island Railroad and Horace Harding Boulevard, and referred to as Section I, was the site of the old Corona Dump of the Brooklyn Ash Removal Co., where over a period of 26 years some 50,000,000 cu.yd. of ashes were deposited. The weight of the ashes, which extended as much as 90 ft. above mean high water, pushed aside and partly consolidated the underlying silt and clay to such a degree that the ashes penetrated below the original surface as much as 40 ft. When the initial grading operations were completed by the removal of more than 6,200,000 cu.yd. of ashes from the top of the dump, a thick blanket varying from 20 to 60 ft. remained. The presence of this blanket of ashes made it desirable that the main exhibition buildings for the Fair be located in this "cut area", that is, the portion of the site from which ashes were removed during the 1936–37 grading operations.

In addition to a description of the general geological formation, the report contained information which led to the following basic conclusions regarding the foundations:

(1) That spread foundations for heavier constructions should be confined to the areas previously loaded by large depths of ashes, and where, after final grading, a considerable depth of ashes remained over the underlying silt and clay.

(2) That where loads were to be placed in recently filled areas, settlements of considerable magnitude could be expected, and where ash fill over the Meadow was shallow, loads should be limited to a maximum of 300 lb. per sq. ft.

(3) That where structures were to be built, filling should be done prior to the construction of the foundations.

(4) That grading, or modification of existing grades, should be limited to a 3 per cent slope where the fill of ashes was relatively thin over the original ground.

Studies made in connection with the design of foundations for the

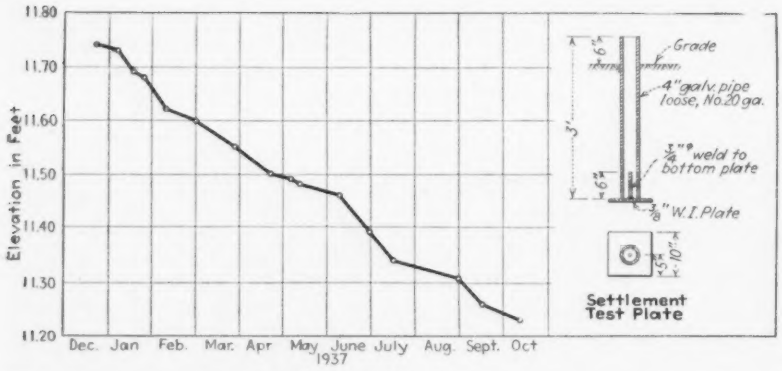


Fig. 2. Typical settlement plate and record of the measured settlement of one plate over a period of ten months.

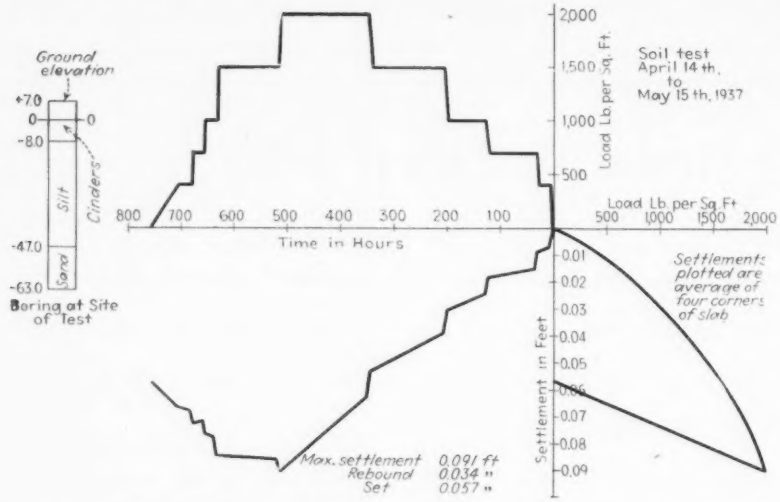


Fig. 3. Soil loading tests were made using slabs 5 and 10 ft. square. Here shown is the loading and settlement of one 10-ft. slab. Note the considerable rebound.

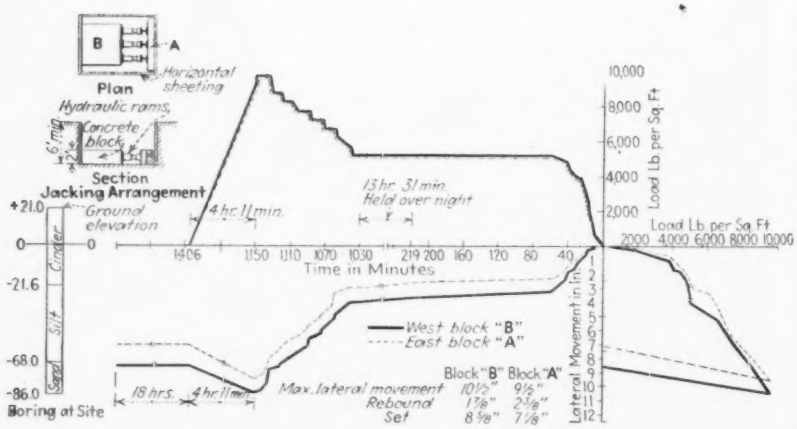


Fig. 4. Lateral soil tests were made 6 ft. below the surface to determine the horizontal passive resistance of the cinder fill.

permanent improvements developed the following:

(1) That timber piles with tips not less than 6-in. diameter, driven through the marsh silts and clays and penetrating to proper depths into the underlying sand, could be safely relied upon to sustain vertical loads of 15 tons each.

(2) That large groups of timber piles should be spaced so as to distribute the load to the underlying sand at an intensity of not over 2½ tons per sq. ft. This intensity was considered generally safe but, depending on the character of the underlying sand, might be modified in various locations.

(3) That excavation for large deep basements would require sheet piling driven to a proper cut-off in the underlying sand, this sheet piling to be adequately braced.

The experience gained during the grading of the site was, in the main, a practical confirmation of the findings of the Moran & Proctor report to the Park Department, such findings having been in part deduced from laboratory soil tests. During the grading period, a number of settlement plates, Fig. 2, were placed at various points in Section I and settlement and displacement readings were taken from time to time. Portions of the site where the fill had been in place for many years showed little or no signs of movement, while in other areas where the fill of considerable depth had been placed during the grading operations settlements as great as 1½ in. per month were noted, but no lateral displacements.

Experimental foundations

The first foundation constructed at the World's Fair was that for the Administration Building covering an area of 58,000 sq.ft. At this site borings were made, test piles driven and loading tests made on both piles and subgrade. Since the Administration Building was but two stories high of steel frame and timber joist floor construction, and was sufficiently flexible to permit differential settlements, interior foundations were, in general, spread footings designed to distribute the column loads to the soil at an intensity of 1,000 lb. per sq.ft. The exterior of the building being of stucco construction with many windows required greater protection against settlement to prevent cracking; for these foundations untreated timber piles, driven to bearing in the underlying sand and capped with rein-

forced concrete, were used. The maximum loads on the timber piles were taken at 15 tons per pile under dead and live load and 18 tons per pile with dead, live and wind loads. Records kept of this building during the first few months after its completion indicate a maximum settlement of approximately 1 in. for the spread foundations (though most of the spread footings show much smaller values), while for the timber pile foundations the maximum settlement was approximately $\frac{1}{8}$ in.

Soil loading tests

The next step in the development of the soil conditions consisted of making a large number of borings throughout the main exhibition area and amusement sections. The principal results of the soil borings were the determination of the thickness of fill overlying the silt and clay and the elevation of the sand underlying the soft clay and silt stratum. At the same time a series of soil loading tests, pile driving tests and pile loading tests were undertaken. The soil loading tests consisted of loading 10 x 10 ft. plates and 5 x 5 ft. plates. These plates were loaded by small increments up to 2,000 lb. per sq. ft. and the plate allowed to come to rest between increments of load. The results of the soil loading tests were plotted in the manner indicated in Fig. 3, and from analyses of these tests allowable unit pressures were decided upon. A test to determine the horizontal passive resistance of the cinder fill was made by jacking against a 2 x 6 ft. concrete plate, the results of which are illustrated in Fig. 4.

The principal result from the pile driving tests was to secure information regarding the amount of penetration that could be obtained in the underlying sand which would permit of placing of orders for a large quantity of timber piling to be used for construction purposes. Previously driven piles were selected for loading tests and these were loaded up to 36 tons by increments and the results plotted in a manner similar to that used for the soil bearing tests. Several of the piles were also submitted to lateral loading tests. Some of the piles which had been subjected to loading tests were later utilized for bench marks and it was quickly noted that some

Fig. 5. The Perisphere is carried on a heavily reinforced ring girder of concrete supported on creosoted piles.

of these piles were settling. An investigation indicated that the piles themselves had not been driven into the underlying sand but were finding their support in the skin-friction of the silt and clay. Since the ground surface was settling as a result of consolidation, the piles were forced deeper into the ground due to the drag of the consolidating material. One of the piles settled as much as $\frac{1}{4}$ in. per month.

A summary of soil and pile tests is given in Table I.

Communications Building started

The second foundation designed for the Fair was that of the Communications Building and was started before construction of Administration Building had advanced far enough to demonstrate the action of spread footings. The south end of the Communications Building is located in the "cut area". The north end of the building, however, is on ground where new ash fill was placed during the grading operations. Three soil loading tests were made on the building site, which indicated that the ground at the north end was quite variable in its bearing capacity. The total depth of ashes over the site was from 24 to 30 ft.

Conservative design would have called for pile foundations, at least for the north end of the structure, but there was some discussion as to whether piles were essential. While the Administration Building had been designed with both types of foundation, the column loads in the Communications Building were generally much larger.

TABLE I—SUMMARY OF PILE AND SOIL LOADING TESTS

(Total from all sources)

Borings	482
Pile Bearing Tests	32
Pile Driving Tests—no load	9
Lateral Pile Loading Tests	6
Soil Bearing Tests:	
10′x10′ slabs	16
5′x5′ slabs	5
Other tests	5
Lateral Soil Tests	3
Soil Movement Tests	16

It was finally decided to use spread footings throughout the building, deliberately, as an experiment to demonstrate whether heavy column loads could be so supported on recently filled ground. The footings at the south end were designed for soil pressure (surcharge loading) of 1,000 lb. per sq. ft. The north wing was designed for 550-lb. per sq. ft. on the exterior footings, and 700 lb. on the interior footings which carried the heaviest loads. It was anticipated that some settlement of the structure would take place, and provision was made to permit jacking up of any columns in case the differential settlement of adjacent footings should become excessive. Level readings were taken on the footings and columns at intervals

from the completion of the footings in August 1937 until February 1938. These levels indicated a general settlement of the entire building, varying more or less uniformly from the south end to the north end. While some of this settlement occurred before the steel structure was erected, and corrections were made when the steel columns were placed, the total settlement of the steel structure in five months varied from 1½-in. at the south end to a maximum of 5¾-in. at the north end of the building.

It was apparent that the ground under the building was experiencing a general consolidation due to the weight of the building and to the pressure of new fill. The maximum settlement occurred in the part of the site where the depth of new fill was greatest.

The settlement was of no consequence as long as it varied uniformly from one portion of the structure to another. However, there was some variation from column to column. Longitudinally, the maximum variation between adjacent exterior columns was $\frac{15}{16}$ in. but some of this differential settlement developed before the exterior wall was placed, as there is very little cracking showing in the stucco of the completed walls of the building.

The largest differential settlements of adjacent columns occurred in the transverse steel bents. These consisted of two high interior columns supporting a truss of 70-ft. span, and two lower exterior columns connected to the interior columns by wind trusses of 20-ft. span. Differential settlement in these bents would cause development of secondary stresses in the steel frame. The maximum differential settlement of adjacent columns in any one transverse bent was $1\frac{3}{16}$ in.

An attempt was made to forecast the future trend of these settlements through the life of the Fair by plotting the time-settlement curves as parabolas. This study indicated that the settlement of one particular bent might become appreciably larger.

A detailed analysis was made of the steel structure to determine the effect of settlement upon the stresses in the structure. It was found that if this progressive settlement should take place it would cause excessive strain on the steel structure. Accordingly, for the particular bent under consideration, it was decided to jack up the two interior columns in order to counteract the effect of settlement. Otherwise no changes have been made in the structure on account of settlements.

It is felt that the foundations of the Communications Building have proved entirely satisfactory. While the settlement of the structure has caused some extra expense, this has been less than the saving in cost of spread footings as compared with the long piles that would have been required in this location.

Spread footing widely used

As a result of the various investigations made and from the experience gained in connection with the spread footings used for the Administration Building and the Communications Building, the majority of the buildings located in the so-called "cut area" were placed on spread footings. Various types of materials were used for the construction of spread footings, some being of reinforced concrete, others of timber grillages, while an additional type consisted of timber mats with structural steel distributing girders. The relative costs of the different types of footings, including disposal at the completion of the Fair, did not vary materially. All the types referred to have certain special advantages which made them adaptable to certain local conditions.

Outside of the "cut area" where settlement plates indicated that the ground surface was settling at a comparatively low rate and where

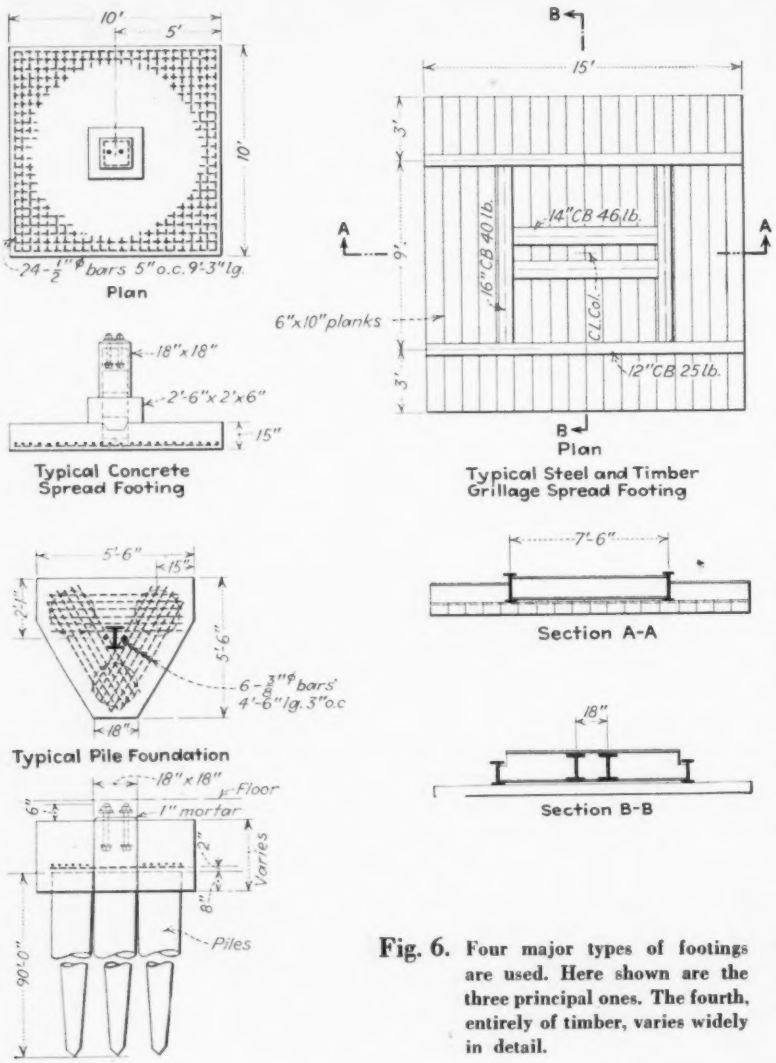


Fig. 6. Four major types of footings are used. Here shown are the three principal ones. The fourth, entirely of timber, varies widely in detail.

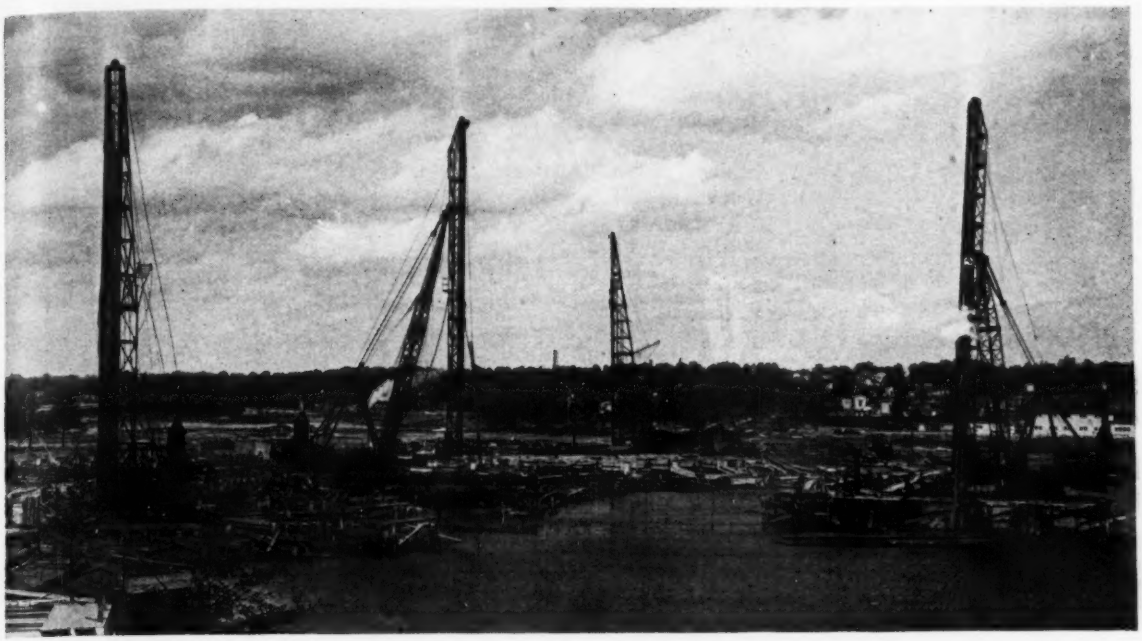


Fig. 7. Pile drivers working on the Amphitheatre and its stage in Fountain Lake. Built by the New York State World's Fair Commission as one of the permanent structures of the future park, the Amphitheatre is supported on concrete piles.

there was an adequate depth of ashes, pile foundations are used to support columns only, while the floors themselves are constructed directly upon the ground surface. In the majority of cases it has proved more economical to use reinforced concrete pile caps although in certain instances timber caps are used. In locations where ground surface is settling rapidly, or the thickness of ash fill is extremely thin, it was decided to support not only the columns but also the ground floor on timber pile foundations. The pile caps usually are of reinforced concrete and in some cases the girders supporting the floors are of timber. In most instances, the use of reinforced concrete girders in combination with reinforced concrete pile caps has proved to be the most economical type of construction. Smaller pile clusters could be used as the girders aid materially in tying the various caps together and also serve to take up the eccentricity in small pile groups resulting during the pile driving.

Effect on cost

The extensive use of piles in the foundations has not greatly increased the building costs. In nine of the buildings where spread footings were used, having a total ground area of 571,267 sq. ft. the foundation cost, including grading, averaged 8½ per cent of the total building cost. In five buildings where piles were used to support the structure, with a total area of 268,052 sq. ft., the foundation cost averaged 12½ per cent of total cost. In two buildings where both floor and structure were on piles, the ratio was increased to 19½ per cent. For this entire group of sixteen buildings the average ratio was 10½ per cent which compares favorably with experience on standard building construction.

It may be pointed out that where there was a choice between using piles or spread footings at reduced intensity of soil pressure, the advantage in cost was generally in favor of the pile design.

Permanent building foundation

Permanent structures built by the World's Fair which will remain in Flushing Meadow Park generally have been constructed on foundations using creosoted timber piles wherever the cut-off is carried above ground water level, it being felt that creosoted timber would be more durable against exposure to the organic acids in the marsh soils. These structures consisted of a field house, utility building, boat house and five over-pass bridges.

The low level bridges over the Flushing River are mainly of boardwalk design consisting of timber pile bents supporting plank and joist decks, with decorative hand-rails and in some cases hedge boxes. A temporary high level bridge over Flushing River and extensions to the permanent bridge over Horace Harding Boulevard for use of bus and pedestrian traffic have been built on untreated timber pile foundations with reinforced concrete pile caps. Extensions to permanent bridges over Grand Central Parkway are on spread footings.

East of the Flushing River, opposite the main exhibit area, will be the Foreign Government Group. The foundations and the ground floors of these buildings are supported on timber piles with reinforced concrete pile caps and floor girders.

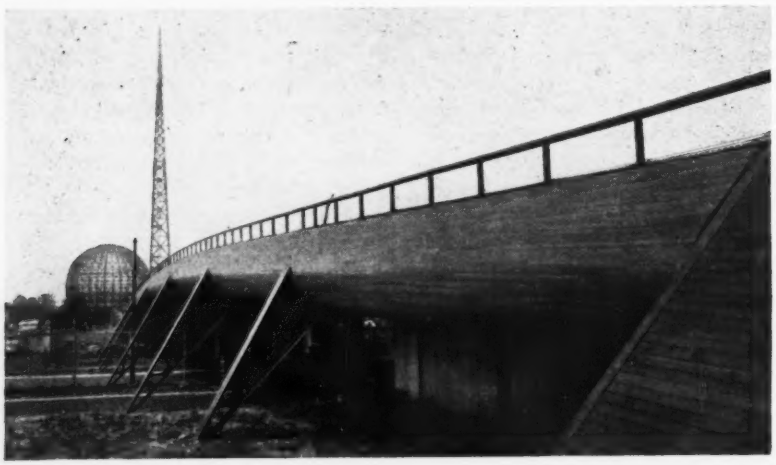
Just north of Horace Harding Boulevard in the southeast portion of the exhibit area are a number of buildings devoted to state participation. This group extends on both sides of and partially over the Flushing River. Their foundations are all of timber piles and where the construction extends over the Flushing River the pile caps also are of timber, while the floors and walks are supported on pile bents with timber caps. Certain buildings of this group which are sufficiently far from the

river so that the concrete work may be laid directly on the ground surface have foundations of timber piles with reinforced concrete pile caps and girders.

Throughout the entire Fair area, the foundations for buildings built by the various foreign governments, states and exhibitors, have closely followed the forms of construction investigated and adopted by the World's Fair, as a result of their researches and experience.

Foundation of Theme Center

The Theme Development, consisting of the Perisphere, Trylon and Helicline, because of its unusual character, is of special interest. In the design of these foundations many forms of construction were investigated, and from the standpoint of economy and because of the degree of permanency required, owing to possible popular demand for retaining these structures after the Fair, creosoted timber piles, 95 to 100 ft. in length, were used for the Perisphere and Trylon foundations. The foundations for the Perisphere consist of 528 timber piles, capped with a circular reinforced concrete mat 3 ft. 3 in. in thickness and 14 ft. 6 in. wide. In order to secure the greatest amount of vertical stiffness and at the same time distribute the column loads to the foundations, a reinforced concrete circular ring girder, 4 ft. thick and 8 ft. high, was used to transfer the load from the columns to the pile foundations. For the Trylon, the timber piles were capped with three hexagonal concrete mats, two of which are 7 ft. thick and 40 ft. 6 in. least diameter, each resting on 157 piles while the third mat, which receives an additional load from the escalator bridge joining the Trylon to the Perisphere, is 7 ft. 9 in. thick and 46 ft. least diameter. It rests on 199 piles. These hexagonal mats not only transfer the vertical loads to the pile foundation, but are buried beneath the ground surface so that the dead weight will provide an adequate factor of safety against uplift produced by wind pressures. The Helicline, which is a ramp descending from a height of 50 ft., is supported on steel pipe columns decreasing from 30 in. in diameter and spaced at diminishing intervals from a maximum of approximately 26 ft., all supported on reinforced concrete spread footings. The footings are buried in order to secure adequate dead weight to provide the necessary factor of safety against overturning. Soil pressures in the foundations were limited to a surcharge load of 1,000 lb. per sq. ft.



FAIR BRIDGES

Permanent bridges built for park service have been widened by adding temporary structures at each side to carry the World's Fair traffic. The temporary walks are outside the iron railings in the lower picture. The exterior surfaces are natural finished wood.

FORMAL GARDENS IN THE COURTS ADJOINING THE THEME CENTER

Landscape Plan for the Fair

GILMORE D. CLARKE

Landscape Architect, Member, Board of Design, New York World's Fair 1939

Ultimate use of the Fair site as a city park made possible an unusually extensive tree and shrub planting program to beautify the grounds

THREE HUNDRED ACRES of ash dump and nine hundred acres of treeless marsh land to be converted into lawns, flower beds and tree-shaded plazas in two years; that was the problem put before the landscape architects for the New York World's Fair. The desolate waste chosen for the Fair site presented the landscape architects with a task of greater magnitude than ever before undertaken for such an exposition, but the fact that the grounds ultimately are to become a city park both justified and make possible a tree moving and shrub planting program that would not have been warranted were the land to be used for other purposes after the Fair closes its doors.

Previous articles have told how the 1,200-acre site was graded for the exposition grounds and how material removed in leveling the high parts of the ash dump was spread over the widest possible area of marsh land, the available material being used as a rough guide in determining how much of the lowest of the marsh land along the Flushing River should be dredged to make the two lakes that will be a major feature of the permanent park as well as important elements in the layout of the Fair grounds. Over 800,000 cu.yd. of marsh muck was excavated from the low lands and much of it was processed for use as topsoil for later planting operations.

Areas outside the exhibit and amusement sections are considered as permanent landscaping, where lawn areas, planting beds and tree pits have been prepared to normal depths. In the exhibit and amusement areas, which are occupied by the temporary structures of the Fair, the lawns are thriving on a thin layer of three to four inches of topsoil over the existing ash fill. Flower beds and evergreen hedge plantings have drainage provided to insure quick run-off of surface water where operations have caused compaction. Tree pits have been dug to an average depth of four feet and a width equal to one-half again the size of the tree ball. Within one year of transplanting, the roots of the large trees have penetrated through the topsoil into the ash fill. The vigorous condition of the trees one year after planting proves their adaptability to the artificial conditions of the site.

The planting program was started well in advance of the huge program of erecting the Fair buildings. Movement of mature trees up to 55 ft. in height to avenues, streets and plazas was inaugurated in the spring of 1937.

Availability, general character, adaptability to local conditions and ease in transplanting governed the selection of tree types. The specifications of the contract for trees pro-

Fig. 2. Trees up to 55 ft. high are being brought in to the grounds. Large trees weigh as much as 25 tons due to oversized soil masses.

vided graphic standards indicating the desired proportions of height and spread to guide the contractors in locating acceptable trees. To date, five states, Maryland, Pennsylvania, New Jersey, Connecticut and New York, have sent trees to the Fair grounds.

Fig. 3. Trees are carefully guarded against injury.

As over-size soil masses were specified for each tree, some of the larger specimens weighed around 25 tons each. To check evaporation and prevent dessication, trees were completely covered with wax emulsion shortly after they had been reset and carefully guyed and barricaded against injury by the construction operations.

Trees have arrived mostly by truck from an average distance of 60 miles. Regular tree movers of the cradle type, as well as flat bottomed trailers have been employed to carry the trees to the site. Tractors, block and falls, and winches provide mechanical assistance in sliding the trees into place.

The trees planted at the site include American and Asiatic elm, red and Norway maple, swamp oak, pin oak, red and shingle oak, gray and black birch, catalpa, ginko, locust, willow, crabapple, sweet gum, oriental plane, cockspur thorn and white flowering dogwood. No attempt has been made to build up a collection of rare and unusual plant life.

In making the general plan for the Fair, the Board of Design determined that a definite proportion of the area should be left open for landscape treatment. Many beautiful pattern gardens have been laid out in these areas. Every court and every building is to have some landscape treatment. Never in any Fair or in any other landscape development have such quantities of flowering plants been used.

The vista along the major axis of the Fair, Constitution Mall, is over a mile in length, starting at the Theme Circle and terminating at the Federal Building. In formality and scale this view across the exhibit area suggests that in the gardens of Versailles. The vista is bordered in part by double rows of red maples, mature specimens 12 in. in caliper and 35 to 40 ft. in height.

Night lighting of trees

Trees are to become a major element of the lighting effects. The fact that the tiny veins on the underside of tree leaves become luminous when exposed to mercury-vapor light rays furnishes the basis for unique lighting effects in the Central Mall and the Theme Center plazas. Each of the stately trees in these areas will be flooded with light from mercury-vapor lamps installed out of sight in the ground but projecting vertical beams into the foliage. The resultant effect will be a greenish-white luminescence.

The beams of light emerging from the ground will have the appearance of fountains. Experiments show that this type of illumination will provide an unusual, restful atmosphere, entirely free from the garish effects commonly associated with exposition lighting. Carrying out the plan will mean that the Mall and plazas will be entirely free of lighting poles and lamp standards.

During the spring of 1938 most of the formal gardens and courts of the exhibit area were completed. The west shore of Fountain Lake has been planted with informal masses of native trees and shrubbery, and facing the water's edge are thousands of naturalized marsh plants.

Landscaping of all areas to the north of the Long Island R.R. and to the south of 69th Road will be finished by the end of 1938 and by that time the remainder of the landscape program will be near completion. Exhibitors will execute the landscaping of their plots during the late fall of 1938 and the early spring of 1939. To insure a mature and established setting, some exhibitors have planted large trees in advance of construction. Exhibitors landscape plans must have Fair approval.

Design of Exhibit Buildings

R. H. SHREVE

Shreve, Lamb & Harmon Architects; member of the Board of Design, New York World's Fair 1939

Schematic designs based on most economical use of floor areas for exhibits given to architects for development of final building designs

IN THE DEVELOPMENT of a comprehensive general plan of the Fair, the Board of Design had to consider a number of building types, their relation to the general plan and their relation to one another, and to determine those characteristics which would best fit the structures to their functions. In some ways the most important building would be that at the center of "emotion," the climactic point about which complementary buildings, avenues and planned areas would be organized. This center of gravity has in the present plan become the Theme Center, a brilliant tour de force from the hands of Messrs. Harrison and Fouilhoux. There are of course other buildings of special significance, such as the federal group, the foreign government group, the buildings of the states, and the building erected by the city of New York, the last being a permanent structure to hold its place after the World's Fair has given way to the park. There also will be structures of unusual types in the amusement area and of special types about the grounds for service, maintenance and administration, but there is not opportunity in these notes to do more than mention these buildings, if space is to be made available for brief reference to the buildings through which move the vital functions of the Fair—the exhibit buildings.

The exhibit buildings necessarily would be the first to be erected. Their placing, with the development of the main avenues, fixed the general scheme of the Fair and provided elements of a like character, running through the fabric of the plan, to tie together the other architectural units to which reference has been made and the buildings later to be erected by private exhibitors to house their own displays.

To review the accomplishment and experience of other great expositions and to determine those influences in the New York Fair which would be controlling in determining the types of structures to be erected, a working committee was set up under the direction of the Board of Design. Visits were made to the then current events, the Great Lakes Exposition at Cleveland and the Texas Centennial Exposition at Dallas. Persons associated with these projects were brought into the work of the New York World's Fair group. Information was gotten on foreign practice in Paris, London, Brussels, Barcelona and Dusseldorf, and in Canada at The Canadian National Exhibition at Toronto, and leaders in these fields of exhibit technique were consulted in fixing New York's program.

Building types developed

When it came to working the results of these studies into definite outlines for the structural form of the fair buildings it was agreed that space above the first floor was difficult to "sell" either to the exhibitor or to the public. Only very unusual attractions or special interests can make such space active in the exhibit program. The New York Fair thus became a first-floor show. It was found, too, that for the general exhibitor, space of great height is not useful. Those desiring space of such a character could generally be expected to build their own buildings. For the average exhibitor high space involved high exhibit expenditure quite disproportionate to the result obtained, and this without reaching personally any greater number of visitors than could be interested by means of an exhibit of lesser height. It was agreed, too, that special spaces of unusual shape had proven less widely saleable than standard units which could be used singly or combined to permit large spaces to be secured where desired. Thus, while some higher centers were provided, building unit bays 20 ft. in depth, generally 20 ft. in width and up to 20 ft. in height, were established as the "cell" system about which the buildings were to be organized.

Arrangement of aisles

Aisles broad enough for free circulation without hindrance from persons standing at exhibit fronts were recognized as necessary. In some cases single aisle circulations were placed between exhibit spaces facing the aisles on either side, giving an over-all building width of 60 ft. In other cases a central island 30 ft. in width for special types of exhibits was flanked by an aisle on either side with exhibit spaces between these aisles and the exterior walls, thus producing a building 110 ft. in cross section. This development of typical buildings is shown in Fig. 1.

It was decided not to attempt to control the circulation of visitors but rather to indicate a course of travel which, when followed, would take in all points of interest. An effort was made to avoid alternate courses in which where one is taken the other is missed.

After full allowance for this circulation system and after taking out general space uses, such as information centers, toilets and storage spaces, concession booths and, in some cases, restaurants, it was possible to secure over 50 per cent efficiency, that is, to have over one-half the floor area saleable space.

A measure of the very satisfactory result obtained from this method of "calibration" may be seen from the

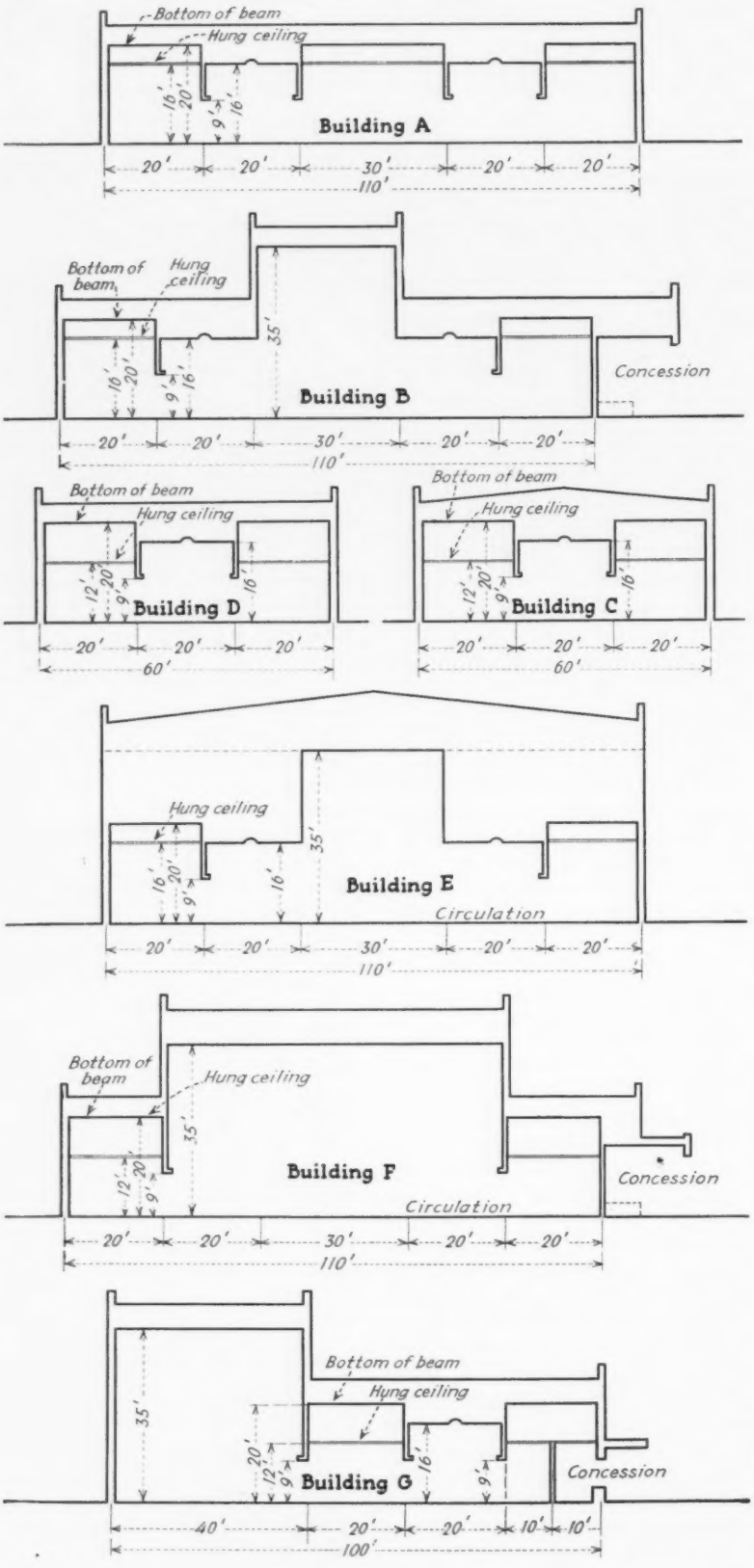


Fig. 1. Five types of buildings having ideal arrangements of 20-ft. and 30-ft. wide exhibit areas and 20-ft. aisles were developed by the Fair staff for guidance of architects of exhibit buildings.

following review of what was accomplished:

At the time the forecast was made it was thought that 1,400,000 sq.ft. gross area would produce 450,000 sq.ft. net sales area at a cost of approximately $7,000,000. Through careful study and collaboration of the designing architects, the Board of Design, and the corporation staff, 1,159,000 sq.ft. gross covered area has been made to yield 510,000 sq.ft. net sales area at a cost substantially less than had been anticipated.

The record then is, less gross space, more sales area, lower unit cost and less total cost.

The charge to paying participants was set at a rate per square foot which would amortize the cost of the structure during life of the Fair, since all the exhibit buildings are to be removed when the Fair is closed. For this reason it was felt that cost should be kept low, materials to be selected with short-lived usefulness in view,—but also with consideration for architectural quality.

Structural framing studies

A careful study of various possible structural types preceded determination of final structural design. Light steel frames were adopted after careful analysis of many alternate forms and thorough comparison of their respective costs per square foot of covered space. The method used is indicated in Fig. 2.

Accumulated structural and live loads were concentrated at column points for transmission to spread footings or to pile foundations. These column points not alone permitted the standard system of subdivision of floor area, but effected economies over other methods of support and made more simple the correction of settlement if any should take place.

These preliminary studies for individual exhibit buildings were first set up in a "schematic plan" prepared in the office of the Board of Design, which plan was reviewed by the Fair corporation's representatives, including the production group, those handling concessions, rentals, etc. Suggestions made by these groups were embodied in a "revised schematic plan" which was then sent to the architect chosen for any one building for development and incorporation of his ideas of architectural

treatment. The architect thereafter, working with the board and the Fair staff developed a preliminary scheme, a set of fundamental sketches, and finally, definitive drawings which contained an expression of the architectural approach without incorporating purely structural design or mechanical installation.

Exhibitors' layouts, which constitute the greater part of the internal treatment, are submitted through the Fair corporation to the Board of Design for approval and are executed through contracts privately arranged by the exhibitor.

Building code for the Fair

By an act of the New York state legislature, the Fair corporation was empowered to adopt a building code, subject to the approval of the New York City Board of Estimate. The act provided that such building code would govern the construction and maintenance of buildings not intended for use after the termination of the Fair.

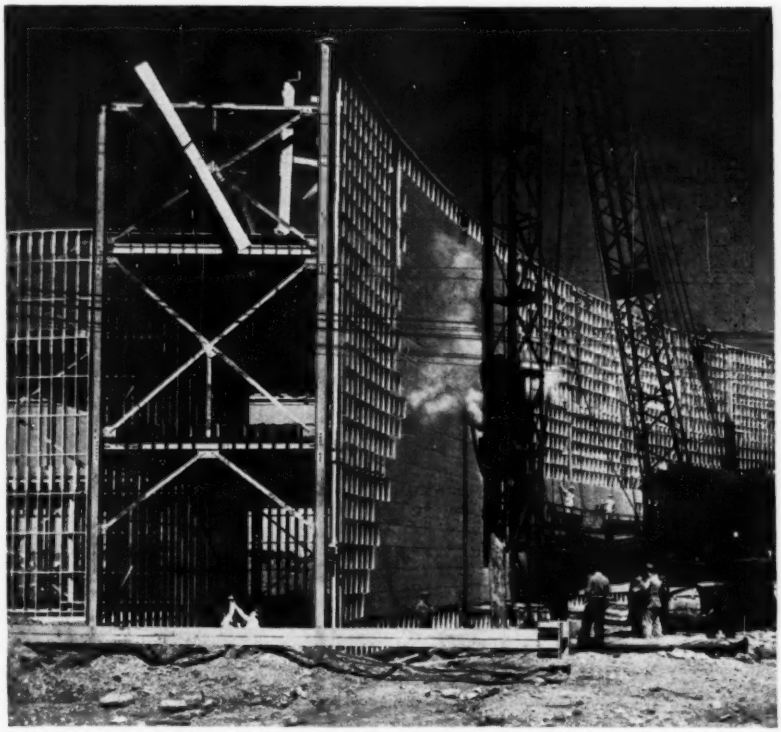
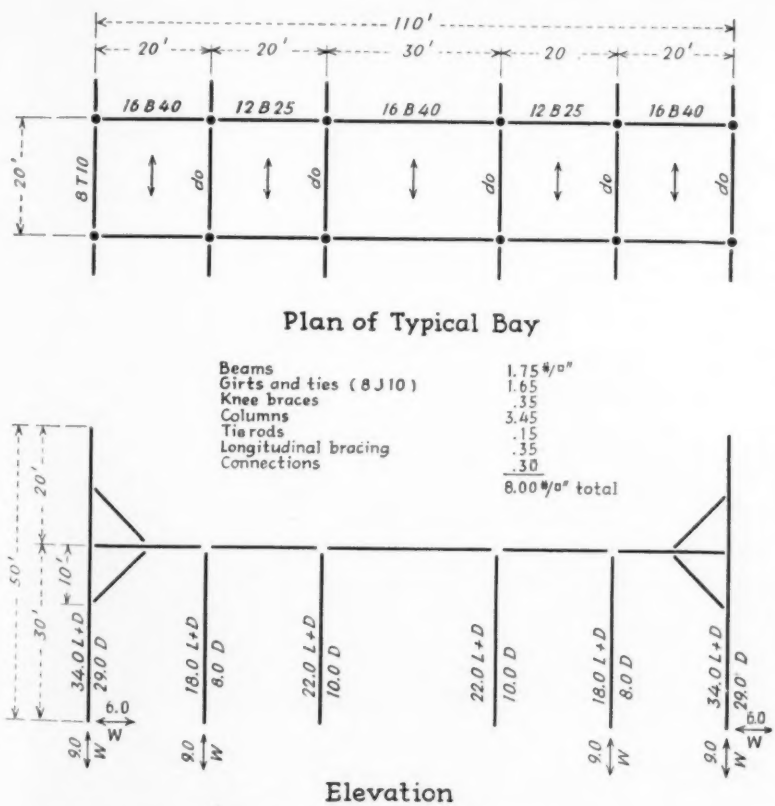


Fig. 3. Steel framing, timber studding and asbestos board are the usual form of wall construction on exhibit buildings, stucco being used on exterior surfaces.



NOTE: Roof construction of wood; ⅞" sheathing; 2" x 10" joists, 24" o.c., bridging. Column reactions in Kips (W = wind)

Fig. 2. Work sheet from the engineer's study of simple framing for exhibit buildings. This is the sheet of Building A, Fig. 1. Uniform column spacing in most bays simplified framing.

In the late Spring of 1936, Grover A. Whalen, president of the Fair corporation, appointed William Wilson (architect and engineer) chairman of a committee to draft a code for the Fair. Other members were Alderman Edward J. Sullivan, then chairman of the committee on buildings, Board of Aldermen, and Bernard J. Gillroy, then technical adviser to the Board of Aldermen on the New York City building code, Franklin E. Parker, Jr., Amos T. Smith, Victor J. Cucci, Alfred H. Eccles, Philip E. Langworthy and A. D. Stark. A special administrative board at the Fair rules on all matters relating to the code.

Building codes of previous and then current expositions were studied by the committee and three then current expositions were inspected by Chairman Wilson. It was decided to pattern the Fair building code after the then proposed New York City building code (now law) and, while making due allowance for the temporary nature of the structures, to require a higher standard of con-

struction, fire resistance, fire extinguishing equipment and plumbing than prevailed at any previous or then current exposition of similar nature.

While the fire resistive standards are below those of the city code for permanent structures in the city, exit facility requirements are far more severe as are also the provisions governing fire extinguishing equipment. Prescribed fire resistive requirements become more severe as the heights above grade of occupied floors increase.

Practically all structures are designed for a fire-resistive rating of one-half hour, which calls for noninflammable sheathing on each side of studding and other structural members. Gypsum board ½ in. thick is adequate for this purpose and is used quite generally for both exterior and interior walls. Interiors are generally finished with fabricated board types in standard sizes.

Exterior walls generally are of stucco; it was felt that materials revealing joints often have the effect of destroying the scale and mass of buildings on which they are used, and to some extent prove less resistant to weather. Where gypsum board is used the stucco is applied to welded wire mesh nailed to the surface, the stucco being applied in three coats giving a thickness of about ⅞ in.

Insulation of exterior walls is provided by aluminum foil, generally on the studding side of the interior sheathing. In some instances rock wool was substituted for aluminum foil.

Cost studies

Cost was studied carefully in two ways: One, by analysis of costs of similar structures at Chicago, and the translation of these cost units to New York conditions with due allowance for elapsed time and comparative local conditions; the other, by taking off quantities and estimating probable cost, making such allowance as seemed possible for price changes before the structures could be completed. Comparison of the two resultants indicated that a fair approximation of ultimate cost might be obtained by allowing $5.00 per square foot of covered space.

To simplify the process of applying this cost-approximation unit to designs prepared by different architectural offices, the total unit figure was broken down into:

(a) Foundation
(b) Floor structure, and
(c) The super-structure or "tent."

Thus any required combination of unit cost data could be made—and the probable cost of a submitted design could be established in terms of the use of standard methods, or of devising special methods of construction suited to special designs.

As a great experiment in collaborative design, the structures of the Fair promise a splendid success.

Sites and types were to some extent fixed by the adoption of the general plan prepared by the Board of Design. To the design of the individual building problems have come groups of architects of all schools of thought, one group assigned to each Fair-built building. These architects have had entire freedom within the essential limita-

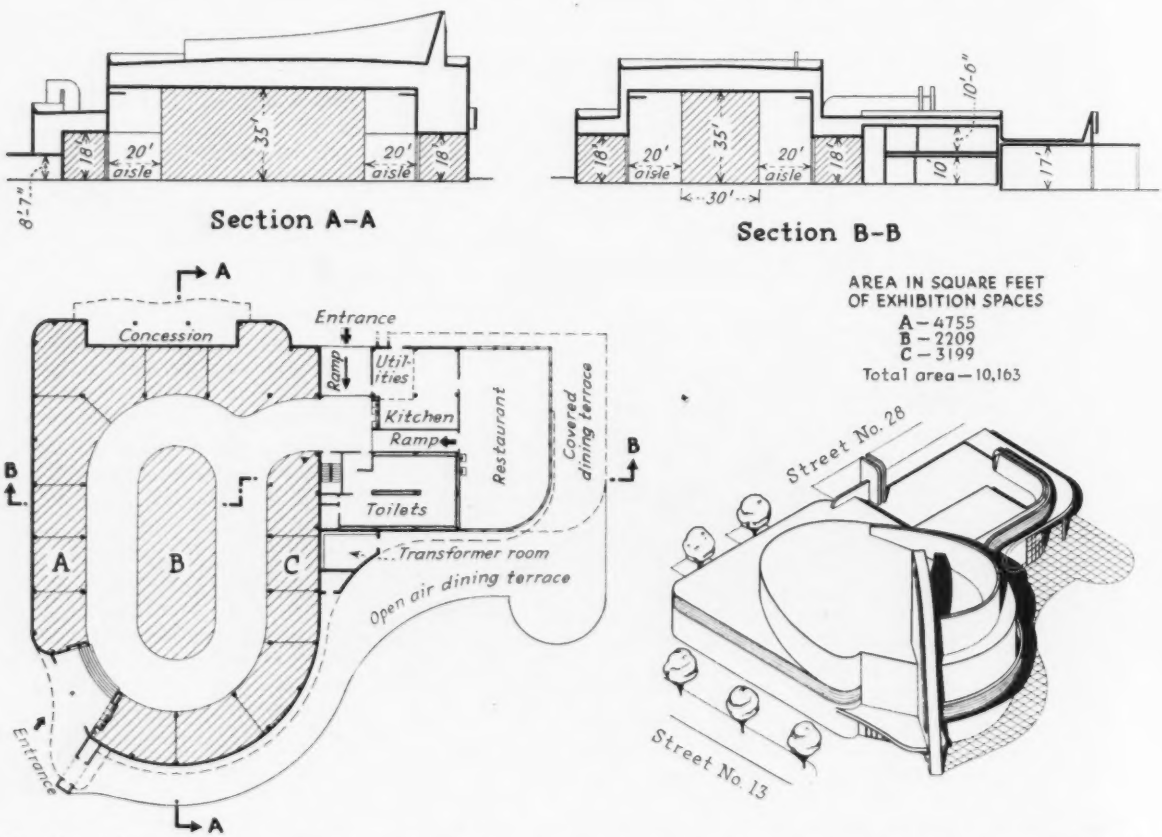
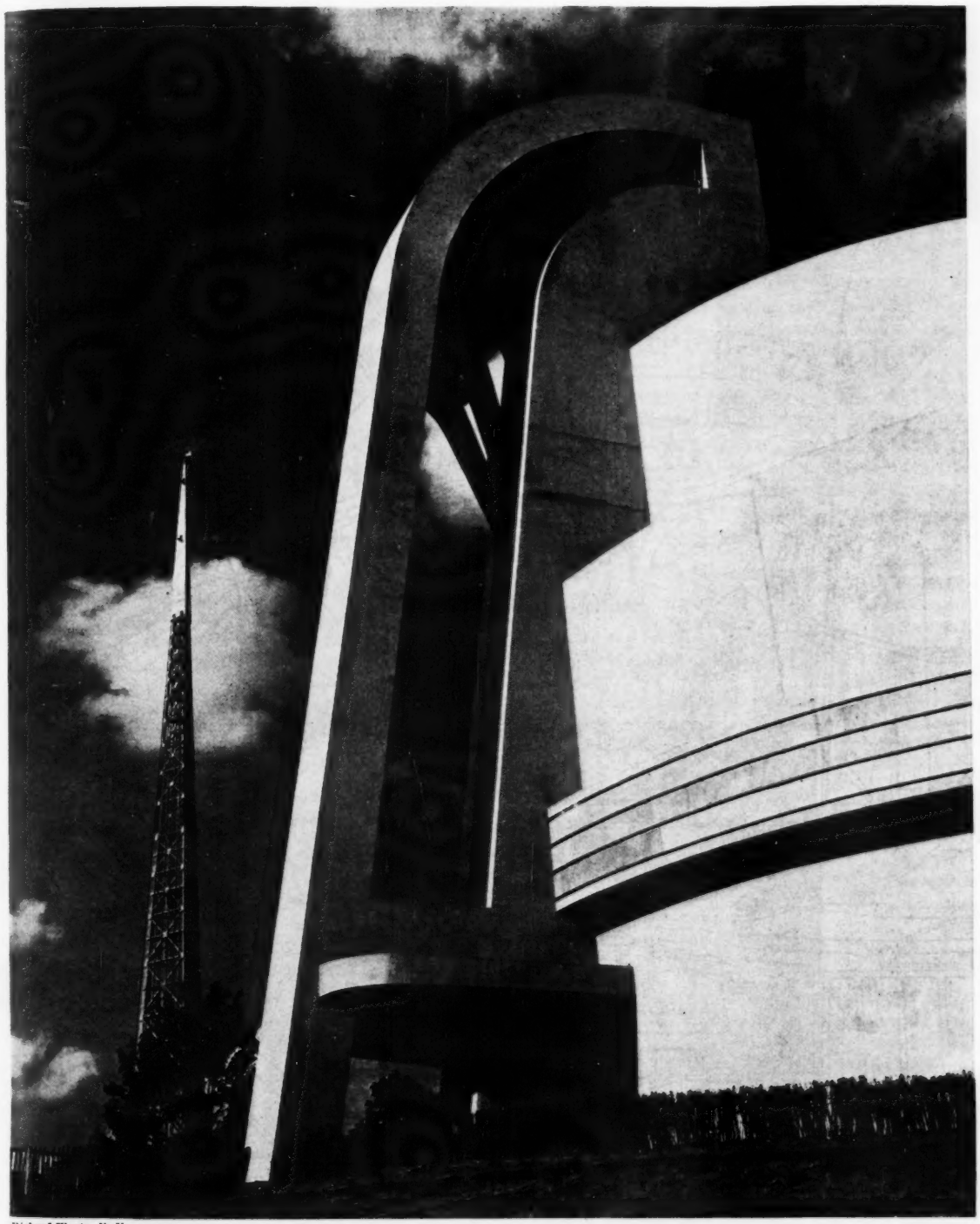


Fig. 4. Individual exhibit building designs were developed from the basic forms shown in Fig. 1. In this drawing building Type A is used in development of the final design for the Electrical Products Building.



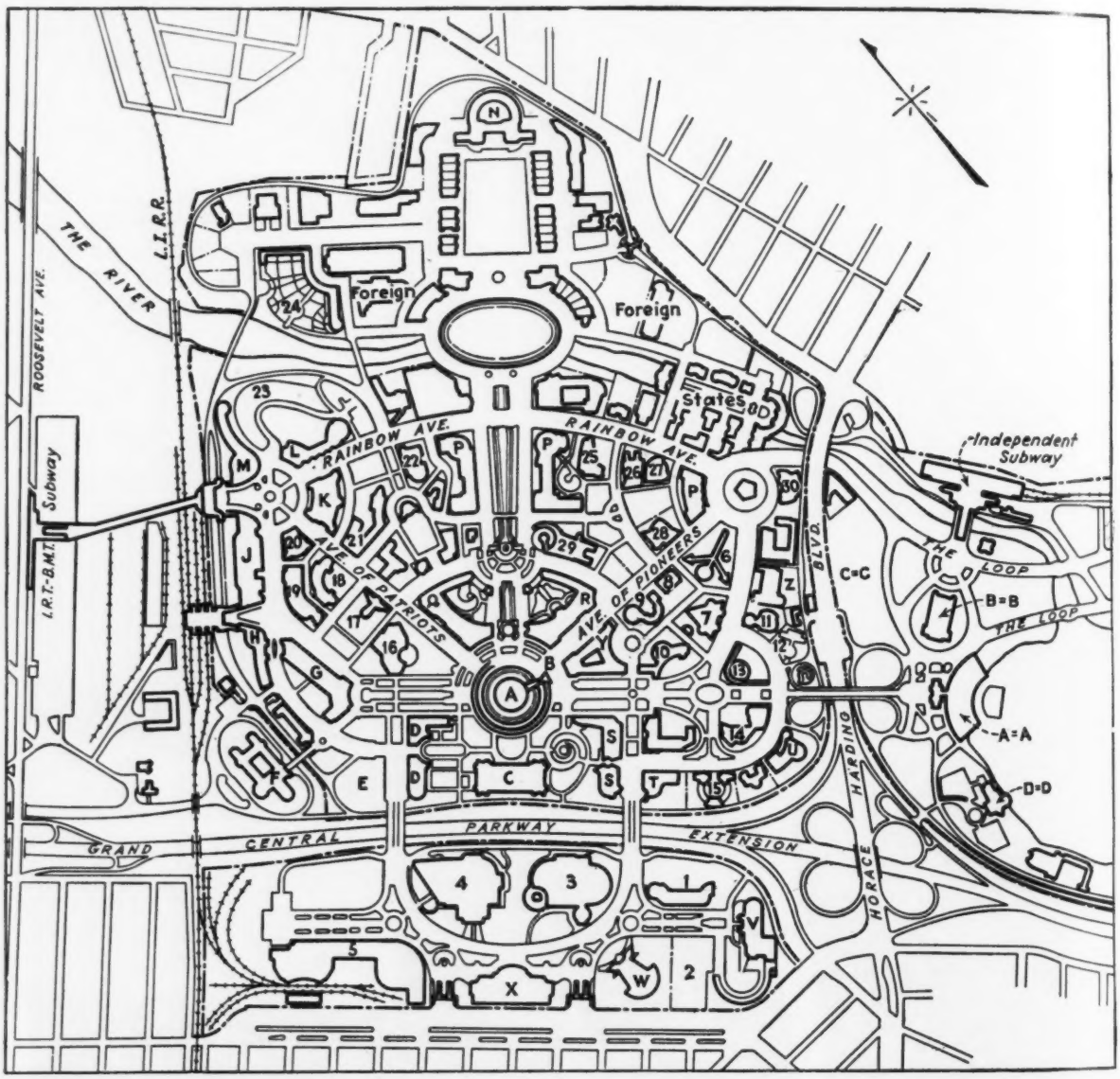
Richard Wurts, N. Y.

Plans and sketches take concrete form. The Electrical Products Building developed from the isometric drawing shown in Fig. 4.

tions of area and cost imposed by the exhibit program and the budget. These buildings and their interrelation establish the backbone of the scheme in which exhibitor buildings designed by architects privately selected have been incorporated.

It is worth noting that the private exhibitor buildings evidence acceptance of the basic principles of the design of the Fair-built buildings, their "schematic" plans, accessibility and simple circulation and the use of materials and of color. To these the private-exhibitor buildings add, as they should, a note of individuality, and often of self-expressive gaiety,—affording a variety while maintaining a harmony with the general concept.

The many visitors to the Fair who are sensitive to the value of an effort to coordinate the essential elements of such a plan, will recognize the ever-present unity of expression which has been sought and of which the structures are but a single part.



Principal structures in the exhibit area: A, Perisphere; B, Trylon; C, New York City Building; D, Business Systems; E, Art Museum; F, Administration; G, Communications; H, Cosmetics; J, Textiles; K, Home Furnishings; L, Contemporary Arts; M, Building Materials; N, Federal Building; P,P,P, Food; Q, Medicine, Public Health, Science and Education; R, Consumers; S,S, Pharmacy; T, Electrical Products; U, Production; V, Marine; W, Aviation; X, Transportation; Y, Metals; Z, Chemicals and Plastics; A-A, Amphitheatre; B-B, Music Hall; C-C, Children's Hour; D-D, Terrace Club.

Principal private exhibitors: 1, Firestone; 2, Mack Truck; 3, Ford; 4, General Motors; 5, Railroads; 6, Swift & Co.; 7, Petroleum Industries; 8, American Tobacco; 9, Glass, Inc.; 10, Consolidated Edison Co.; 11, DuPont; 12, Carrier Corp.; 13, U.S. Steel; 14, General Electric; 15, Westinghouse; 16, American Tel. & Tel.; 17, R.C.A.; 18, American Radiator Co.; 19, Apparel and Accessories Association; 20, Johns-Manville; 21, American Gas Assn.; 22, Beechnut; 23, Town of Tomorrow; 24, Horticulture; 25, Distilled Spirits Institute; 26, Standard Brands; 27, National Dairy Products; 28, Continental Baking Co.; 29, Borden Co.; 30, Eastman Kodak Co.

Water, Sewers and Services

L. B. ROBERTS

Assistant Chief Engineer, New York World's Fair 1939

Service utilities designed to meet demands for water, sewers, power and light in a city of 800,000 population

BASIC ASSUMPTIONS of the demand on all public utilities within the Fair grounds during the Fair period were made after a detailed review of the experience records of other fairs. In fixing the carrying capacities of trunk lines for electric current, for water supply, sewage collection and similar services, care was taken to insure that adequate reserves were provided to allow for possible changes in the Fair development plan during the construction period.

All utility lines are designed primarily to serve an anticipated maximum daily population of 800,000 persons in the Fair. Because of the impossibility of forecasting the exact distribution of points of concentrated demand, factors of safety were increased arbitrarily at certain areas. As the World's Fair site is to become a part of the New York City park system after the Fair is over, it was evident that the utility distribution systems would be a compromise design between the permanent lines desired for park operation and the temporary lines needed for the Fair. Naturally the capacities provided for Fair operation were considerably in excess of the requirements of the permanent systems which will remain for park use after the termination of the Fair.

Physical arrangement of the underground systems was made to provide a maximum number of points of connection. Due to the fact that the exhibit areas are subject to rental and transfer throughout the construction period and that the nature of the exhibits could not be fixed with finality prior to installation of trunk lines, service had to be made available on practically all frontages of each lot in the Fair.

Fortunately, sources of supply of water, gas and electricity are available and are well located about the boundary of the site; also, the arrangement of the exhibit areas permits frequent interconnection of services as a safeguard against failure of any single source. No great difficulty was encountered in fixing the particular locations of the main lines in the streets.

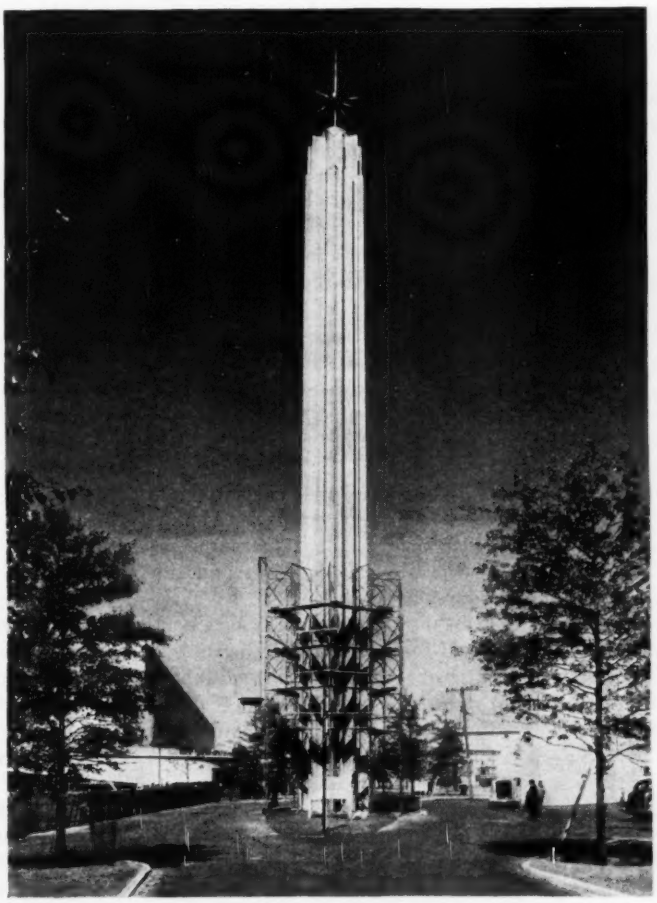


Fig. 1. A conspicuous element of the lighting will be the Star Pylon, a structure 132 ft. high which is faced with polished wood to reflect lights concealed in the recesses.

The exhibit buildings are constructed without cellars and therefore practically all of the trenches in the area are shallow. While this condition required constant care of design to avoid conflict in location of the various utilities and to provide continuous drainage for sewers, gas mains and similar lines, there were compensating advantages. These advantages consisted of better foundations in the ash fill and lessened construction costs. Where the subsoil was of insufficient bearing capacity to guarantee that displacement would not occur, additional supports were provided in the form of grillages and pile foundations. In some locations a common foundation supports the water main, sewer and storm water drain. Such a grouping is shown in Fig. 2.

The supply for the 4,150 v. distribution system in the World's Fair grounds is obtained from the Consolidated Edison Co. Two sub-stations were built by the Fair and connected to the 27,000 v. feeders. The ultimate capacity of these two sub-stations is 90,000 kw.

Coordination of the illuminating equipment for the buildings and lighting displays in harmony with the spirit and construction of the buildings and the exhibits within these buildings was accomplished after research and laboratory experiments.

The complete underground distribution system consists of concrete manholes, concrete and wood ducts for the telephone, fire alarm and telegraph cables. The light and power feeders from the two substations are segregated in separate manholes and separate ducts. The communication lines are also segregated.

The cables for light and power are non-metallic sheath cables of special construction to suit the local conditions, both mechanically and electrically.

At the termination of the Fair the 4,150 v. cables will be removed from the underground system and utilized in a network system of lower voltage. Approximately 40 per cent of the light and power underground system and street lighting will remain as a permanent improvement when taken over by the city.

Water supply system

All permanent water main construction is subject to the approval of the New York City Department of Parks and the Department of Water Supply, Gas and Electricity. Prior to installation of the mains, agreement on the principle of design was reached so that the system could be easily converted for irrigation of the more extensive planting that will be made for the park after the Fair is over. Construction of the permanent mains is in accord with the standard city specifications for mains in business and residential areas. However, installation of asbestos-cement pipe is permitted in certain areas where the superimposed loads are light and where the subsoil conditions are such that a uniform foundation existed. In other locations either cast-iron or steel pipe is used.

The only special conditions affecting the installation of water mains were the foundation requirements for permanent water lines. One of the more important mains crossing the Fair site is a 20-in. diameter line used for the combined purpose of serving the Fair and acting as a part of the New York City transmission system in the Borough of Queens. This main crosses Flushing River and for a considerable portion of its length passes through areas where pile foundations are required. The pipe line itself is partly cast iron and partly steel plate construction, both heavily treated with protective coatings.

Supply points to the Fair water distribution system are at two pressures. Therefore, regulative devices have been installed to obtain balanced operating conditions. These regulators form an additional factor of safety should there be any increase of consumption above estimates of consumption.

Water for all purposes except display is taken directly from the New York City transmission mains leading from the Catskill reservoir system. It is anticipated that the maximum hourly demand for sanitary purposes, including operation of kitchens, concessions, drinking fountains and comfort stations, will total about 12.5 m.g.d., and that the average daily consumption for these purposes will total 2.5 m.g.d.

Determination of sizes of mains was conditioned upon two principal requirements (a) meeting all demands, including a localized draft for fire fighting (approximately 3 m.g.d.) without reducing street level pressures below 45 lb. per sq. in.; and (b) providing sufficient water for fighting major conflagrations, irrespective of residual pressure. Besides the allowance of 3 m.g.d. for ordinary fires, there will be available in the distribution system a reserve of some 9 m.g.d. by curtailing the use of water for air-conditioning during fire emergencies.

Presence of fire fighting equipment in buildings is mandatory under the World's Fair building code which conforms to the New York City building code. The Fair Corporation has provided three fire stations completely equipped with the most modern motorized equipment. Beside these, city equipment in fire stations immediately adjacent to the Fair grounds is available for additional protection. Hydrants are spaced at 300-ft. intervals along the mains and more frequently in areas of concentrated development.

Water for display purposes

For conservation of water and water pressures, recirculating equipment is mandatory for all fountains and water-using display features. The quantity of make-up water for fountains has been held through these requirements to an estimated average of 400,000 gal. daily. The principal fountain display in the Lagoon of Nations and that proposed for Fountain Lake will not be supplied through the distribution system but will instead take all water from the lakes in the Fair area. Fountain displays will require nearly 100,000 g.p.m.

Included in the requirements for water supply is capacity for a maximum hourly rate of draft of 4.8 m.g.d. for irrigation of plantings. Principal irrigating operations will be done during the night hours so that there will be a minimum of interference with the pedestrian and vehicular traffic during daylight hours.

The intricate landscaping designs limit the plan of irrigation to single hose outlet connections. The outlets are of the flush-surface type spaced at frequent intervals so that they may be operated singly or in groups as may be desired.

Bids for the first sections of the distribution system indicated that little saving could be made by substitution of cheaper materials for the temporary lines. In any event, hydrants, valves and all appurtenances are designed to uniform patterns in the interest of standardization and the only possible saving was on pipe quality. After the early bids were received it was decided to construct water mains for both permanent and temporary use to the same specifications.

Sewers and drains

Sewers and storm drains in the Fair grounds are completely separated. Sanitary sewage is collected by gravity at two principal points of discharge. The outlet from the exhibit area flows by gravity directly to the city sewer system, while the discharge from the amusement area,

in the southern part of the grounds, is elevated by means of three 75-hp. pumps for discharge into city sewers. The city sewers discharge at the activated sludge type treatment works now under construction at Tallman's Island. Sewers in each of the drainage areas are designed for a maximum flow of 10 m.g.d., though the peak loads do not occur simultaneously.

Details of construction are in conformity with New York State Department of Health regulations regarding minimum velocities (2 ft. per sec.), manhole spacings and other construction requirements. Capacities are provided to accommodate all possible peak loads with reserves approximating 25 to 33 per cent of these quantities, depending on the sewer diameter.

Permanent sewers are generally of vitrified tile construction except where it is necessary to support the sewer on pile foundations. In such locations iron pipe is used. This includes a section of the 33-in. outfall sewer in the government area, which is of coated iron pipe.

Storm-water drains

Storm-water drains are limited in duty to draining the area within the Fair boundaries. Run-off from drainage areas outside the Fair grounds, normally tributary to Flushing River, is being completely intercepted through construction of permanent marginal drains by the city.

Drainage of the site itself is comparatively simple. The topography of the ground divides itself naturally into small drainage areas flowing directly to the Flushing River. The largest of the interior storm drains is 60 in. in diameter. All of the drains in firm ground up to 24 in. in diameter are constructed of concrete and larger drains are of corrugated metal pipe as these lie in areas where foundations are not adequate for tile or concrete pipe construction.

Estimates of maximum run-off are determined by the "rational method", using the New York City standard run-off formula. Drainage requirements for the Fair are practically coincident with those of the future park except for minor variations in amount of run-off which will be lessened in the park by replacement of paved areas with grass and plantings.

In return for the installation of permanent water mains and sewers by the Fair Corporation, the city supplies all water and provides for the disposal of sewage. Where sewage pumping stations to be installed by the city are not yet complete, the Fair Corporation has installed temporary pump units so that all sanitary sewage is diverted from the Fair grounds into the adjacent city sewers.

Prior to opening newly constructed water mains for use, the lines and their contents are sterilized and water samples are taken. Should tests of samples show results other than complete sterility, the mains are resterilized until subsequent analyses show complete safety in the use of water.

The operation of all Fair-installed utilities begins immediately upon completion. From the beginning of work on the site, electric current, water supply, sewage disposal, telephone and gas have been supplied to Fair forces, contractors and exhibitors. The load during the pre-Fair period is equivalent in amount to the demands of a city of 6,000 population. Operation of these systems under the direction of the designing engineers comprises all maintenance, repair work, metering and inspection of exhibitors' connections. Bills are rendered in accordance with standard rate schedules to apply through the Fair period.

Since installation of water and sewer systems is complete except for those service connections not yet ordered for private exhibit space, operations is in accord with the routine established for the Fair period. Electric current is also furnished according to similar procedure.

All main lines are installed according to pre-determined schedule well in advance of building erection to permit immediate occupancy of buildings as they are completed.

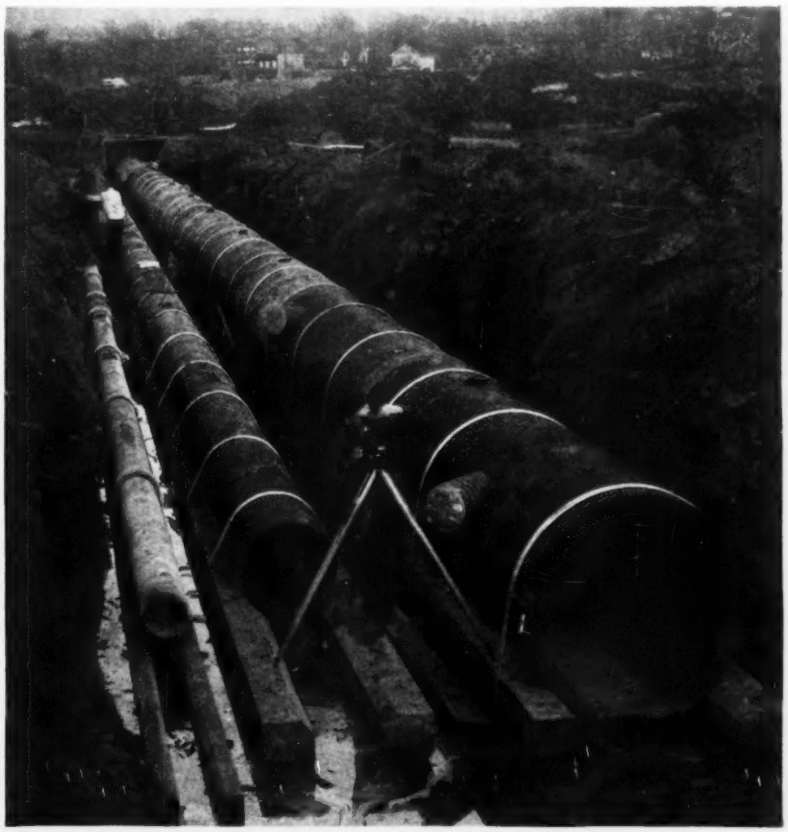


Fig. 2. Water pipe, sanitary sewer and storm drain all in one trench. In soft ground these pipes are supported as here shown, the longitudinal supports being carried by timber piles.

Roads for Fair and Park

HENRY WELLES DURHAM
Paving Engineer, New York World's Fair 1939

Road types for the Fair grounds selected to meet both the Fair requirements and those of park that will occupy the site

THE ROADBUILDING TASK that confronted the engineers of the Fair divided itself into two parts: first, providing temporary roads that could carry the heavy trucks over the soft ground of the site to serve the many operations that had to be carried on before the roads and streets of the Fair grounds could be graded and surfaced, and second, grading and surfacing the permanent and semi-permanent roads that will serve the Fair and park that is to be developed on the site in the future. Construction operations could not wait permanent roads; if the Fair was to be ready on schedule, building construction had to begin even before rough grading of the site had been completed.

The early temporary roads were mere truck tracks following the line of least resistance and avoiding obvious soft places. At first, consideration was given to the possibility of giving these tracks some stabilization treatment to form a suitable road surface, but as the final grading operations gradually produced an approximation to the adopted topography, and as street lines and blocks were staked out, building foundations begun and trenches dug for utility services in the streets, it became possible to confine truck traffic to definite routes along future streets. Consolidation of subgrade was effected by this traffic to such an extent that only a limited amount of grading and ditching was necessary to carry satisfactorily the heavy loads. In some instances cinders were used to provide a better surface, and in a few places it was necessary to construct a corduroy mat foundation of heavy timber covered with a layer of run-of-bank gravel to furnish a base for construction traffic, and to serve later as a sub-base for the paved road.

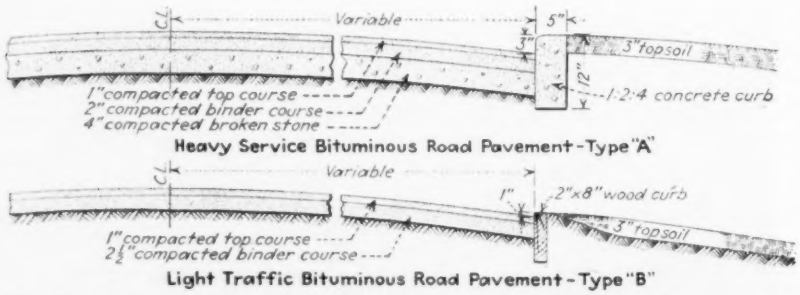


Fig. 1. Heavy-service and light-service bituminous pavements. The heavy section is used only for the temporary roads having bus and other heavy traffic. Concrete is used for those sections of the intra-mural service road that will remain as park roads.

Permanent pavements

Certain roads within the Fair grounds have been built as part of the permanent city plan by state and city agencies. Horace Harding Blvd., crossing the Fair area from

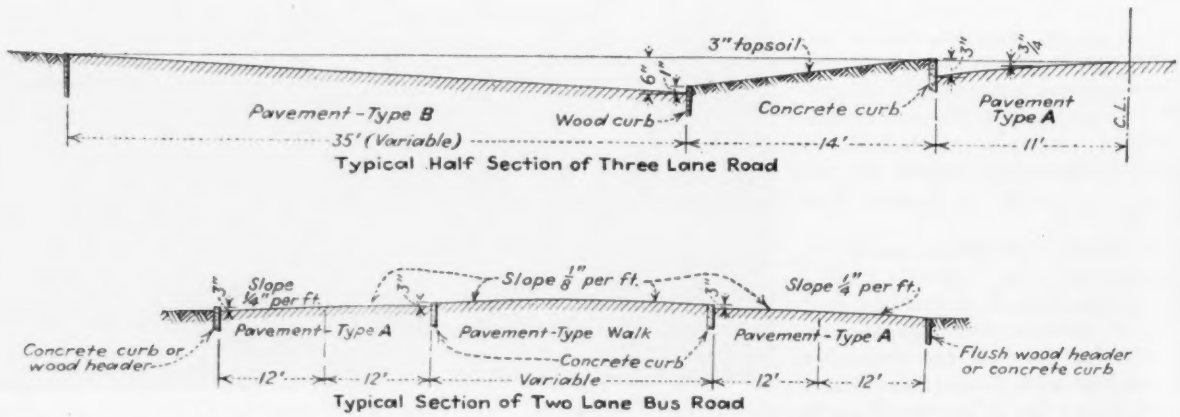


Fig. 2. The three-lane road at the top is used where there is light traffic adjacent to buildings, heavy traffic being confined to the central lane. The lower section shows the intra-mural bus road with a central loading strip.

east to west, is paved with reinforced concrete. Grand Central Parkway Extension also passes through the central part of the Fair site, part of its route being in a cut through the area that formerly contained the greatest mass of the ash mounds and where maximum compression of the underlying silt bed occurred. This part was paved with concrete. The remainder was paved with a temporary bituminous macadam which is to be replaced with concrete before the opening of the Fair.

In the region where the cinder blanket was of greatest thickness and foundation conditions were most stable, the Fair Corporation constructed a concrete intra-mural service road which will remain as a permanent Park improvement. The chief function of this road is to carry the intra-mural bus lines, shown on the map on p. 383.

Street slopes throughout the area are slight, hence determination of grades and cross sections for adequate drainage provided many difficult problems. Where roads are being built through the meadow adjacent to Flushing River an inverted crown cross section with a rolling or saw-tooth profile was adopted.

Designed for settlement

In general, ground conditions are such that some settlement is to be expected. Choice of pavement material therefore was made to meet three conditions: adaptability to making repairs; convenience in making street openings for service connections; and, obviously, cost.

Reinforced concrete, if designed to avoid damage from anticipated settlement, had to be relatively thick and hence unduly high in cost; moreover, the concrete road generally settles unevenly, as has been evidenced by work done on the site. Making of openings and satisfactory repair is difficult. Bituminous macadam, on the other hand, is flexible, easy to repair, both by resurfacing and by patching, and is adaptable to making and repairing openings. Its cost also is low. For these reasons it was chosen for use in surfacing World's Fair roads, except as noted previously.

Two principal types of paved roads have been selected:

For the roads which are to serve as main routes of traffic during and after the Fair, a base course of stone of sizes from ¾ to 3 in. is rolled to a compacted thickness of 4 in. All voids are filled with screenings or sand and re-rolled. On this base is a cold laid plant-mix bituminous macadam in two courses consisting of 2-in. binder and 1-in. wearing surface, substantially in accord with the New York State Highway Specification, Type 3. These roads have concrete curbs.

For the routes of lighter traffic, mainly pedestrian, close to the buildings, a similar plant-mixed bituminous macadam is laid directly on a consolidated base of the existing ash. For such pavement a wood curb is used. This pavement is laid with 2½ in. of binder course and 1-in. top. Walks, especially those in courts and gardens where no wheel traffic is permitted, are also constructed of a bituminous mixture laid on a rolled base of cinders. In order to present a more pleasing appearance, such walks have five to seven pounds per square yard of limestone chips spread over the surface and rolled into it.

Fig. 3. Heavy Traffic Bituminous Pavement and a Two-Lane Concrete Service Road.

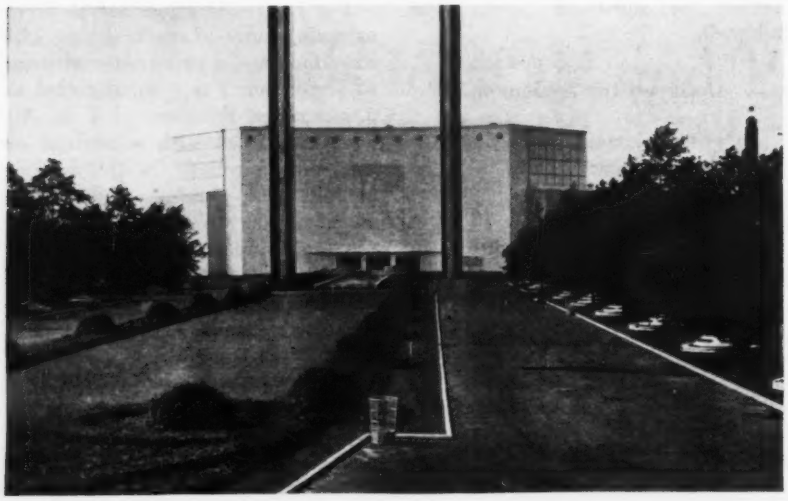


Fig. 4. Light-service pavement in the Court of Communications. Concrete curbs have been set and the base course laid. The wearing course will not be placed until weak spots have been found and corrected.

The type of surface for parking fields is varied in accordance with the local foundation conditions.

Pavements adopted for parking heavy buses are similar to that used on the lighter traffic roads, consisting of a binder and surface course 3½ in. in thickness. For some of the automobile parking fields a single course of asphalt gravel, plant-mix, 2 in. thickness is being used. It is planned to surface certain low areas with rolled broken stone with a seal coat of asphalt and finely broken stone.

There is one feature which strongly differentiates road construction at the World's Fair from that normally experienced by most engineers engaged in paving work in towns and cities. In the latter case the engineer has usually a more or less definite idea of the use to which his street is to be put. He knows its type of development, whether for business, residence, or other use, the probable number and location of sub-surface utility lines and their necessary service connections, and this plan of development is likely to be fixed for a long period.

Designers for the World's Fair, in making preliminary estimates and apportioning the amounts available for the different classes of road construction, had no such definite plan to follow. In particular, the designers of the roads had to estimate the development and costs for a hypothetical group of road surfaces whose cross sections, elevation and alignment were subject to change, whose uses depended on adjacent development not yet defined, and which were planned to serve areas in which no knowledge existed as to the type of occupancy or class of service that would be demanded by the future lessees. The problem, substantially, was the working out of an equation in which all the factors were unknown and the only definite, absolute item was the final cost.

When the road program was started, a sincere effort was made to install all the sub-surface utilities in advance of this construction; but due to the changing plans for development of the site, there was no way to avoid cutting through the pavement for the installation of service connections.

Construction of the million square yards of paving required for the Fair within the time available required that the work be carried on continuously without awaiting completion of adjacent construction for buildings, concession stands, ornamental structures and landscaping. In order that the pavement shall not consist largely of patches over backfilled street openings, normal practice is to delay placing of the wearing surface for a period of about 60 days after construction of the foundation binder course and curbs. With completion of the binder course, traffic is permitted over the road and such street openings as could not be anticipated and are subsequently called for, are made and repaved. The result of this policy is to allow preliminary traffic to develop any weak spots in the subgrade and to permit the consolidation of resurfaced cuts after backfilling. As streets become stabilized and adjacent construction completed the top course is laid, leaving a finished pavement subject to a minimum of deterioration before the Fair opens.

Paving contracts under way and complete at the present time comprise about two-fifths of the total amounts of pavement to be considered. A contract for the remainder recently was let to the Wm. P. McDonald Construction Co., contractor on the earlier work. With this contract let, completion of the paving according to schedule is assured.

Experience with pavements already completed and which have undergone several months' service under heavy traffic, indicates that a satisfactory selection has been made for the conditions encountered.

Fig. 5. Parking areas require 300,000 sq.yd. of paving.

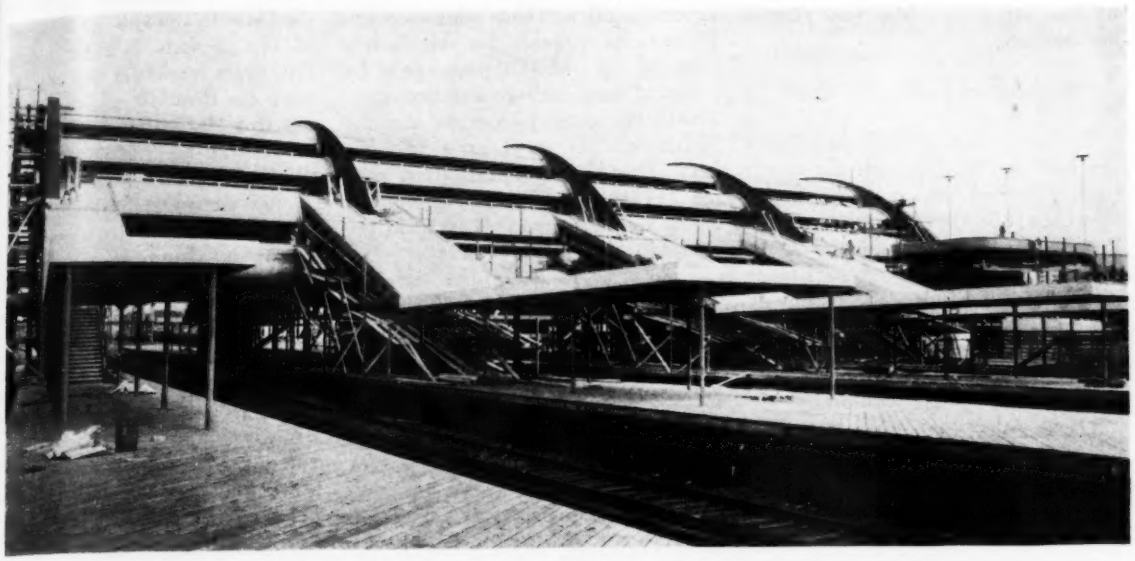


FIG. 1. WORLD'S FAIR STATION OF THE LONG ISLAND R.R. SERVING SEVEN TRACKS

Transport for Fifty Million Visitors

HENRY M. BRINCKERHOFF

Consulting Engineer on Transportation, New York World's Fair 1939

Transport plan based on moving up to six hundred thousand daily visitors to the Fair and facilitating their circulation within the grounds

STATED in broad terms, the transportation problem of the New York World's Fair requires provision for the carrying of 50 million visitors to and from the site in 185 days, or an average of 270,000 per day, and on many large attendance days, from 400,000 to 600,000. Stated in terms of transportation statistics of "passengers carried" this means double the above, or 100 million total rides, 540,000 per average day, and some days of approximately 1 million or more passengers to be handled. These figures do not include World's Fair employees and concessionaires' staffs, estimated at 35,000, which will not, however, travel during the visitors' peak hours. Comparatively few visitors can be housed within walking distance, hence transportation facilities of all types serving all parts of the city area and the major approaches are vital to the success of the Fair.

The above figures have been used as a basis of transportation capacity because while the Fair site is approximately in the geographical center of New York's corporate area it is nevertheless eight miles from the principal hotel, railroad terminal, retail business, and amusement district of the city. Superimposing of this load, which is far in excess of any World's Series, football or convention crowds, upon even New York's extensive transportation systems has required careful detail analysis by the World's Fair engineers and cooperation of all the transportation companies and city authorities.

Analysis of the problem of handling this transportation load for the New York World's Fair fell naturally into two general divisions.

(1) *Exterior*—Including all forms of transit facilities to and from the site.

(2) *Interior*—Supplying means of convenient carrying of visitors about the extended area of the fair grounds.

Fortunately, the transportation lines operating from the heart of the city to or near the World's Fair site (Fig. 2) carry their normal rush hour loads inbound in the morning, opposite in direction to the World's Fair traffic. Trains, therefore, hauling commuters to the city will be largely available for World's Fair visitors on their return trip to their terminals. Similarly, the departing visitors will not travel in general in the same direction during the commuters' peak hours.

In order to determine a reasonable provision for maximum hourly capacity for the World's Fair traffic a detail study was made of the records of one-half hourly periods on typical days of paid admissions and departures at the Chicago Century of Progress. From this information charts and supporting data were compiled and supplied to all the transportation companies. A total required capacity for handling 160,000 visitors per hour was adopted, 100,000 by rapid transit, including

the Long Island Railroad, and 60,000 by bus, street car, boat and private automobile.

Subway and elevated lines

To handle the 100,000 passengers per hour by rapid transit the three-track Corona-Flushing Line of the Interboro and B.M.T. systems, the Port Washington line of the Long Island R.R., and the Queens Boulevard line of the Independent Subway were available, but required extensive enlargement and improvements to meet World's Fair traffic conditions.

The Board of Estimate and Apportionment of New York appropriated $800,000 for enlargement of the Willetts Point Boulevard Station of the Corona-Flushing line, and the World's Fair has built a pedestrian viaduct over the Long Island tracks directly into the Fair grounds. The Interboro Rapid Transit Corp. also undertook the equipping of the third track with signals, switching, etc. for express service. These combined improvements provide for an hourly capacity of 40,000 passengers by trains of the Interboro and Brooklyn-Manhattan subway systems, and the Manhattan Elevated 2nd Avenue Line. This brings express train service to and from these widespread rapid transit systems directly to the northerly end of the Fair.

From the Kew Garden terminal yard of the Queens Line of the Independent Subway, one mile south of the Fair grounds, the Board of Transportation is building a two-track extension along the easterly border of the Fair grounds with a terminal station directly in the amusement area and near the major exhibit and government buildings. This extension provides a 40,000 passenger capacity per hour and direct service from the Independent Subway system serving Manhattan, Brooklyn and Queens boroughs. The city has appropriated $1,700,000 for this construction.

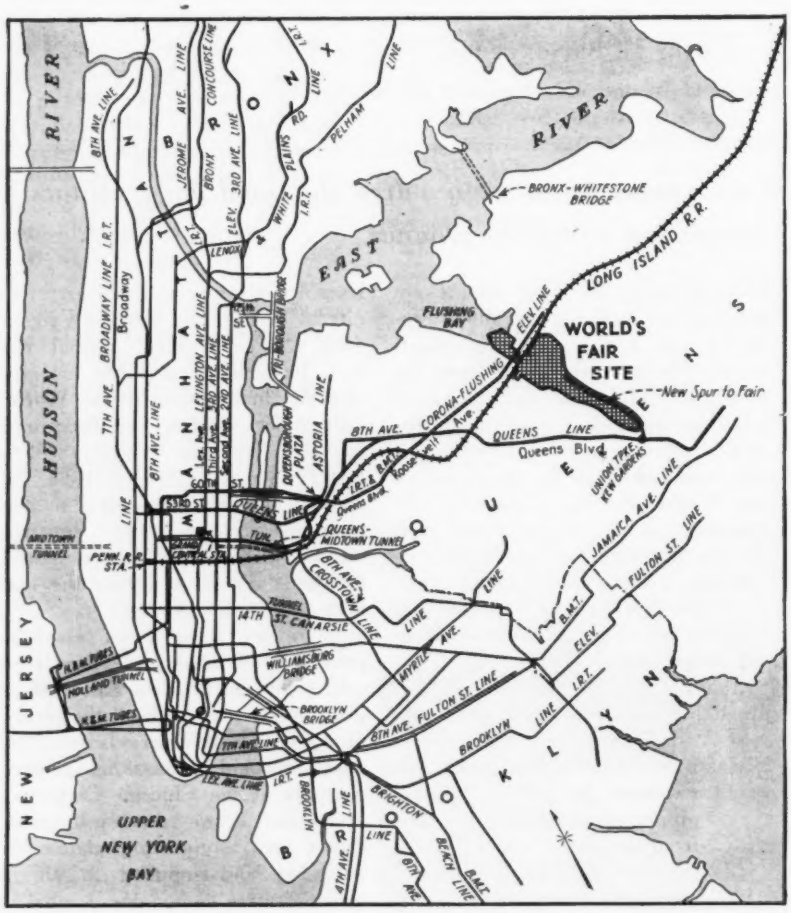


Fig. 2. All rapid transit lines of the city and the Port Washington line of the Long Island R.R. reach the Fair site.

The new World's Fair station of the Long Island R.R. at the north end of the grounds is being built with four extra tracks for a shuttle service from the Pennsylvania Station in the heart of Manhattan. An express service making the run in 14 minutes is planned, with an hourly capacity of 20,000 passengers. Through passenger excursion service direct to this station is also proposed by special trains over the Pennsylvania R.R.

Bus transportation

Delivery of visitors by tripper buses from Manhattan, the Bronx, Brooklyn and Long Island is provided by two loops at the 111th Street entrances on the west side of the grounds. This will route World's Fair visitors directly into the transportation exhibit area. Chartered buses bringing parties from outlying territory will be parked on the north side of the Fair grounds, their passengers entering and leaving by the viaduct from the Willetts Point Interboro-B.M.T. station, or they will be carried by pick-up buses to the Administration Building entrance. Pick-up buses will also carry visitors from the north parking field on Roosevelt Ave. and from the Boat Basin on Flushing Bay to this latter entrance. From the South parking lots, visitors will be delivered directly or by pick-up buses at the 69th Road entrance at the extreme southerly end of the grounds. Additional entrances to the Fair grounds are also provided on Horace Harding Boulevard for the Brooklyn trolleys and buses, and, at the Rodman St. entrance on the east side, busses and cars from the north shore of Long Island and via the new Whitestone Bridge from New England will be handled.

Parking areas for private automobiles are located adjacent to both the north and south ends of the grounds and a boat landing has been built on Flushing Bay just north of the Fair for excursion steamers and pleasure boats. Cooperation by the city and other highway authorities and joint study by the city traffic police, and World's Fair engineers has developed a map that indicates automobile traffic routes which will avoid congestion as far as possible, for outside motorists wishing to drive direct to the Fair.

By this plan nine entrances (Fig.

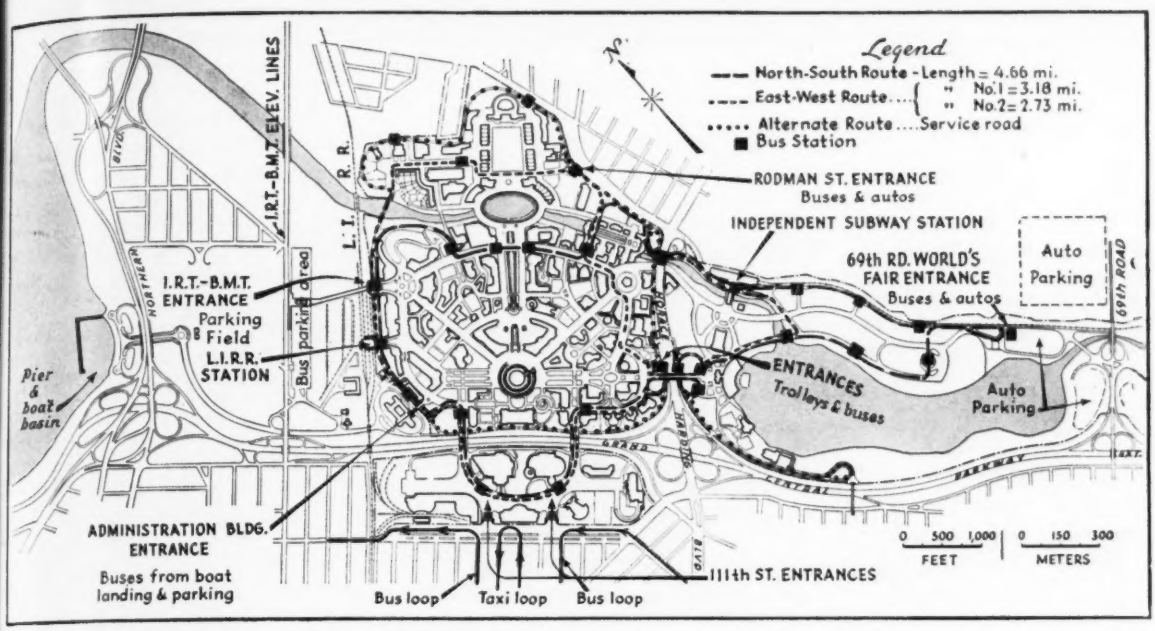


Fig. 3. Intra-mural bus lines passing all main entrances will carry visitors to within easy reach of any point in the exhibit and amusement areas. Their routes are so laid out that they cut across few main routes followed by pedestrians. When there are unusually large crowds the buses can be diverted to the service road where they will be largely free from foot passengers and yet will not be too far from major points of interest.

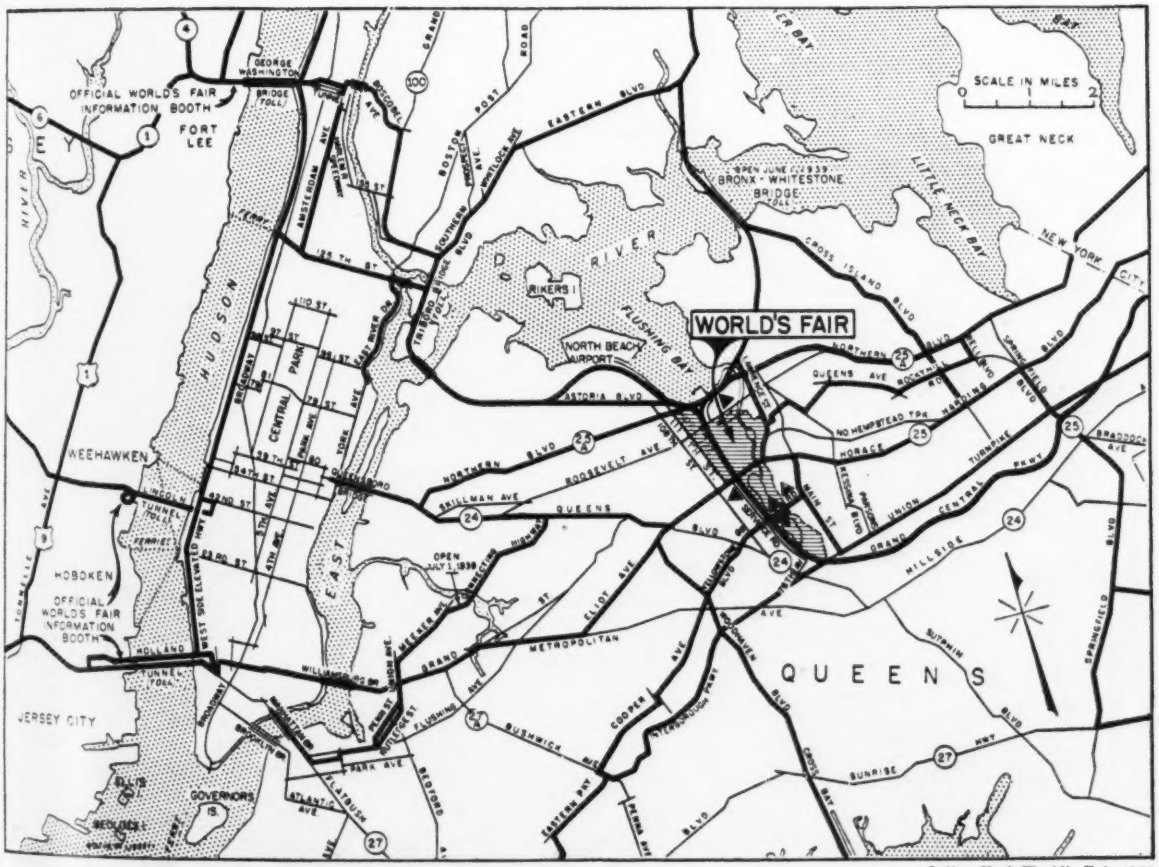


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Fig. 4. Main highways leading to the Fair are to be marked by conspicuous signs bearing the World's Fair symbol. This is a section of the official map to be given to motorists by the police.

3) have been developed on all sides of the Fair grounds in an effort to distribute the incoming and outgoing crowds and provide passenger capacity with the least possible congestion.

Interior transportation

The six hundred acre exhibition area of the Fair is divided into two principal sections by the Horace Harding Boulevard and extends over two miles along its north and south major axis. The east-west dimension is one and one-fourth miles at the north end including the main concession and transportation area, while the southern portion is divided into two parts on either side of Fountain Lake. The southeasterly section contains the amusement or midway entertainments and the west side of the lake will have miscellaneous attractions.

A study of the widely separated entrances to the Fair and the distances to and between points of greatest interest indicated clearly the primary necessity of a comprehensive low cost system for carrying visitors about the grounds. On Fig. 3 there are shown, in heavy broken lines, the routes laid out for a system of buses with 10c. prepayment stations indicated by black squares.

An analysis of the probable visitor distribution and pedestrian densities caused by an attendance of 300 to 400 thousand visitors emphasized the necessity of separating vehicle and pedestrian movements. To this end many of the avenues in the Fair grounds are built as boulevards, with three lanes, a central lane 24 ft. wide being exclusively for vehicles. Pedestrian walks 35 ft. wide are provided on either side, outside of 12-ft. planted strips which separate the pedestrian and vehicle lanes.

Around the outer edge of the main section of the grounds a service road has been constructed and an extension south alongside of the Independent Subway spur will thus provide a marginal private right-of-way for buses free from pedestrians.

Connections from the more central bus routes are provided at many points so that a short detour by the service road will avoid any local pedestrian congestions that might occur, and keep the system in continuous operation. Sightseeing trips by the buses are provided for, when pedestrian densities permit, starting at the main entrances and requiring about one hour for a round trip.

Auxiliary transportation in the central areas where greatest pedestrian concentrations are expected will be by tractor trains similar to those operated at the 1937 Paris Exposition. Designs for wheel chairs for more personal deluxe service are being worked out with manufacturers. A strong effort is being made to develop a taxi chair for two or three passengers, to be electrically driven and operated by an attendant guide, to supply individual service more in keeping with a "Fair of the Future" than the ancient rickshaw or man-pushed Atlantic City type of conveyance.

The objective kept constantly in mind in planning the New York World's Fair transportation has been to supply vehicles of every description from all directions for convenient and rapid access to the Fair and modern flexible low-cost interior facilities for moving about within the grounds. The goal toward which efforts have been directed is to overcome the common complaint at recent large expositions of inability to "see the Fair" without exhausting tramping to a foot-sore, weary condition.

McLaughlin Photo Service

The Fair as it appears today. For identification of structures see key map p. 374

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